THE
POPULAR SCIENCE
MONTHLY.

SEPTEMBER, 1913

THE NITRATE FIELDS OF CHILE

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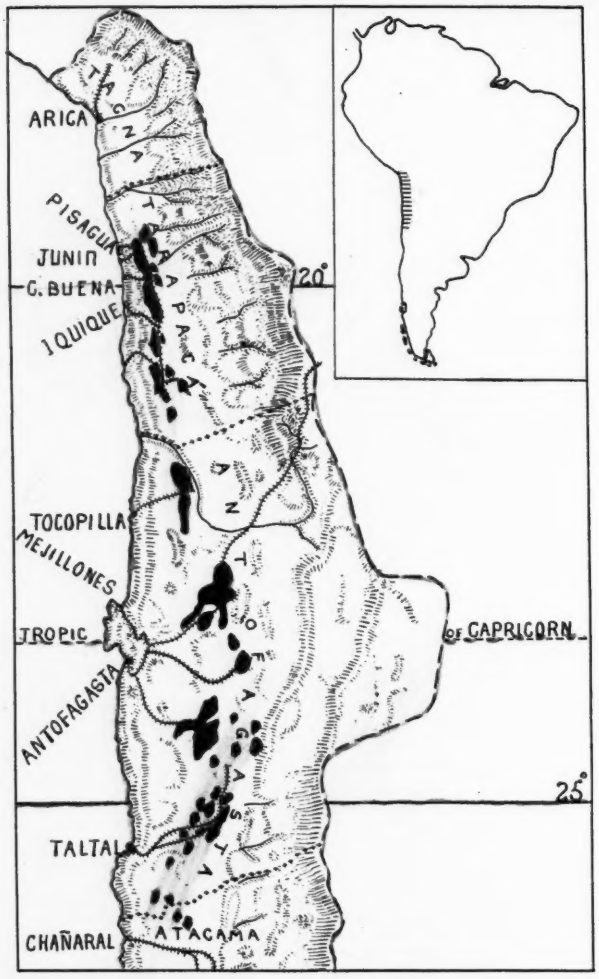
THE importance of Chilean nitrate depends on a curious whim of nature. Nitrogen is needed by all plants and animals, and though the atmosphere is nearly four-fifths nitrogen, few plants and no animals can draw directly on that universal supply. Animals secure their nitrogen through the medium of plants, and most plants must get it from the soil. Some cultivated crops rapidly use up the soil nitrogen and in such cases the easiest way to maintain productivity is by applying fertilizers. Nitrogenous fertilizers once were made largely from guano, fish scrap, slaughter-house refuse, etc., but their manufacture now depends mainly on natural nitrates. These occur in many parts of the world, but they have been found in large amounts only in the northern provinces of Chile.

For Chile itself no other thing has been more important than nitrate in affecting national progress. By some, nitrate has been regarded as a curse; by others, as a national blessing; and spirited arguments over its political aspects may be heard in all parts of Chile, for the question is one of those which time does not settle. Nitrate has led to costly wars which established the prestige of Chile as the leading nation on the west coast of South America. It has lured tens of thousands of people into dreary deserts, and caused busy ports to develop where harbors are such only in name. It has created a great commerce for the country, made fortunes for the people, and provided great revenues for the nation to spend for army, navy and the general welfare. But along with these things, it has turned men and money from more stable forms of industry, and laid the country open to criticism, perhaps unjustly, for its extravagance.

Chile saltpeter, nitrate, or *salitre* as it is called, is when pure a glis-



Sketch map of northern Chile, showing approximate location of nitrate lands (black areas). Cross-lined area on small map of South America shows location of nitrates province.

tening white compound, salty and bitter to the taste, like some sea plants, and capable of absorbing a great amount of moisture. Chemically the substance is sodium nitrate ($NaNo_3$). Pure nitrate is found only in small quantities or "pockets." Commonly it is mixed with earthy materials and various saline compounds, as common salt, Glauber's salt and borax. A small amount of iodine compounds also are present in most cases. This impure raw material is known as *caliche* to the nitrate miner.

Caliche, unlike many raw forms of minerals, is easy to get at, for it lies on or near the surface. In some places, the caliche is covered with 25 or 30 feet of fine dust (*chuca*) and coarser rock waste (*costra*) which must be thrown aside by the miner. In such places, an area which

has been worked looks as though it had been badly furrowed by gigantic ploughshares. In other places, there is almost no overlying material to remove. The layer of caliche may be as much as six feet thick, but for the most part it varies between one and three feet. The beds in some sections are fairly continuous over large areas; in others they are of very limited extent. Some caliche contains more than 70 per cent. of nitrate, but 50 to 60 per cent. is considered high; the average is nearer 20 to 30 per cent., and even as low as 15 per cent. is worked profitably. Hence the conditions of production, costs of operation and profits to be made vary widely from place to place. With few exceptions, however, it is true that the costs of operation are low as compared with many other mining industries, while the profits are large.

The main nitrate fields lie in two provinces, Tarapacá and Antofagasta, between latitudes 19° S. and 27° S. Other deposits doubtless will be found farther south in Atacama, and there are said to be small nitrate areas in Tacna, the most northerly province of Chile. The total area of these four provinces (105,000 square miles) is about equal to that of Colorado and its population (316,000) gives about two per square mile. Most of the people depend directly or indirectly on the nitrate industry. Chileans are the most numerous, but there are also many Bolivians and Peruvians, with smaller numbers of people from half the nations of the world. Only small parts, probably much less than 10 per cent., of the provinces named are workable nitrate lands. These limited areas, together with the seaport cities, contain the mass of the population, while many thousands of square miles contain not a living soul nor any other living thing.

The nitrate beds lie in a belt, commonly less than ten miles wide, about 500 miles long north and south, and 15 to 100 or more miles back from the coast. This short distance from the coast is important in making shipment cheap. Along the coast there is a range of low mountains through which a few ravines offer routes for railroads into the interior. Between the Coast Mountains and the base of the towering Andes lies lower land, known as the *pampa,* which slopes westward from the Andes to the Coast Ranges. The nitrate deposits lie along the western side of the pampa, its lowest part, associated with what were once the bottoms of water-filled basins, either lakes or arms of the sea. Lines of flats, covered with dazzling white salt beds, or *salares,* extend over many square miles. Thus one salt field in Tarapacá covers an area of more than 100 square miles, and salt of remarkable purity (over 99 per cent. pure) is said to extend to depths of scores of feet. Round about these salares are the nitrate lands or *salitreras.* In many parts of the region there is a saying: "Where there is salt there is no caliche." Though this saying holds true generally, there are some places where the two deposits occur together. The presence of nitrate, however, is easily determined. In a manner much like that of using flint and steel

Crossing one of the great *salares* in the province of Antofagasta.

on tinder, particles of any supposed caliche are brought in contact with a strip of burning cotton wicking, or *mecha*. If nitrate is present, the particles ignite sharply, and with no further test an expert can tell approximately the percentage of nitrate present.

The nitrate is so readily soluble that the deposits could not exist even in a moderately rainy region, but there is little trouble on that score in northern Chile. The high Andes on one side and the cold Humboldt or Peruvian current on the other make Chile north of the 30th parallel one of the driest regions in the world. Some places have passed more than a decade without a drop of rain. Other places have a few minutes of scattering sprinkles almost every year. This is said to have been the case in parts of Antofagasta for many years prior to 1910, when there was a heavy shower, followed in 1911 by two days of steady downpour. These occurrences, with rain again in 1912, and, more wonderful still, snow where people living in the region for a generation never had seen snow, have led many residents to believe that "the climate is changing since Halley's comet went past." That water has flowed here at times in the past is shown by the dry gullies and channels. Numerous snow-fed rivers descend the western slopes of the Andes, but their waters soon are evaporated or lost in the dry sands of the pampa. For hundreds of miles along this coast not a perennial stream enters the ocean. If absolute desert exists in the world, it lies in the nitrate pampa.

In crossing this region one can not help feeling the utter helplessness of man in the face of such great expanses of waterless and lifeless wastes. All directions lead to sand, more sand, even to the border of the ocean itself. One fails at first to understand how men are willing to live there year after year; why those who go away generally come back again

A Rio seco, or "Dry River," in a *salar*.

to this apparently limitless desolation. But almost the first day's stay reveals part of the reason. The day is not unpleasant despite the heat and the intensity of the sunlight, for the extreme dryness makes temperatures of 90° or more quite comfortable, and the colors—the grays, yellows, violet—playing over the sands, help make up for the lack of living green. The nights are wonderful—cool, crisp, refreshing, with the brilliancy of sky that only deserts can have; while the moonlight gleaming from millions of salt crystals lights up the land with an effect of half day and renders into attractive forms the most prosaic objects.

Presumably dryness also was a factor in the formation of the nitrate beds. It seems certain from the kinds of rocks found there that the area between the Coast Ranges and the Andes once was occupied by a bay or long arm of the sea. Then the land began to rise, cutting off the bay and converting it into a lagoon, entered perhaps by every high tide. About its borders great flocks of birds congregated—as they do now along the neighboring ocean—to feed on the prolific life in the shallow, warm waters. Enormous deposits of bird guano accumulated about its shores as the years went on. Meanwhile, however, the land was rising higher and higher, water came into the lagoon only from the land, bringing with it soluble nitrates from the guano. But this supply of water was too small to keep up the level; and as the region became drier and drier, evaporation reduced the original sea to a string of lakes occupying isolated basins in the lower parts of the pampa. As evaporation went on, these waters became too salty for life to endure. With their food supply gone, the birds were forced to seek other haunts and the accumulation of guano stopped. Streams and occasional rains, perhaps more frequent then than now, washing away the guano, brought together in the lakes compounds of nitrogen and soda, and the formation of nitrate of soda was the result. Eventually these waters became saturated with the differ-

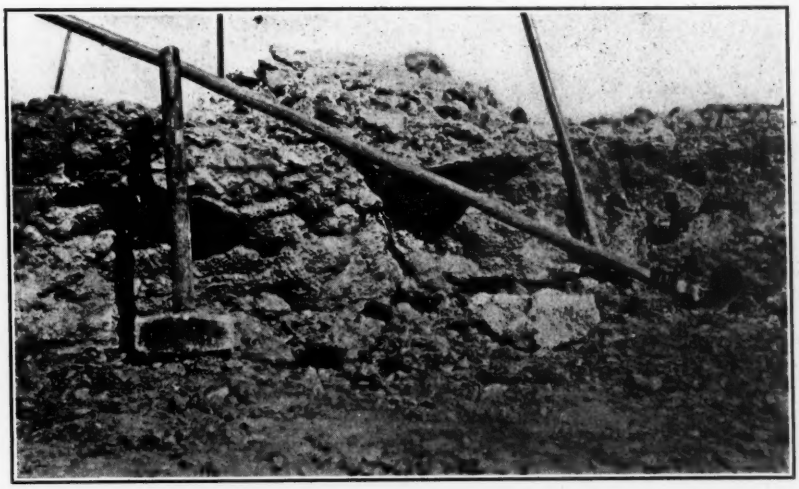
A typical sandy waste. The cross and arrow indicate one of the pipe-lines which carry water to the coast from the Andine streams.

ent salty compounds, and as evaporation still continued, the different salts began to deposit on the pampa, in the salitreras and salares, much as they are to-day. Then as a final step sand and rock fragments from neighboring hills covered the beds with their present capping of loose waste.

Other explanations of the origin of the nitrate have been advanced. One ascribes it to natural chemical processes accompanying decomposition of different minerals. Another suggests that the wonderful electrical discharges in the Andes are responsible, for the odor of nitric acid in the air is not uncommon after severe electrical storms, and electricity even now is being used to extract nitrogen from the air. But the enormous amounts of nitrate in Chile and the geological conditions of its occurrence fit in best with the idea of origin from guano, as stated above.

The fertilizing value of these nitrates is supposed to have been known to the Peruvian Incas, but not generally to have been taken advantage of by them. Tradition also says that Bolivian Indians at an early date came down from the plateau after nitrate to use on their crops, and it credits them, rather doubtfully, with having developed a primitive form of refining. Rich pieces of caliche, so the story runs, were boiled with water in great earthen pots, called *cachuchos,* after which the solution was allowed to cool and evaporate until crystallization of nitrate resulted. Fairly pure nitrate can be secured in this way. Some of the earliest manufacturers for commercial purposes are said to have followed almost the same method, and the principle is exactly like that of the modern process. Even the name "cachuchos" still persists, though the great steel or iron boiling tanks of to-day scarcely suggest "earthen pots."

Prior to the nineteenth century the outside world knew little or noth-

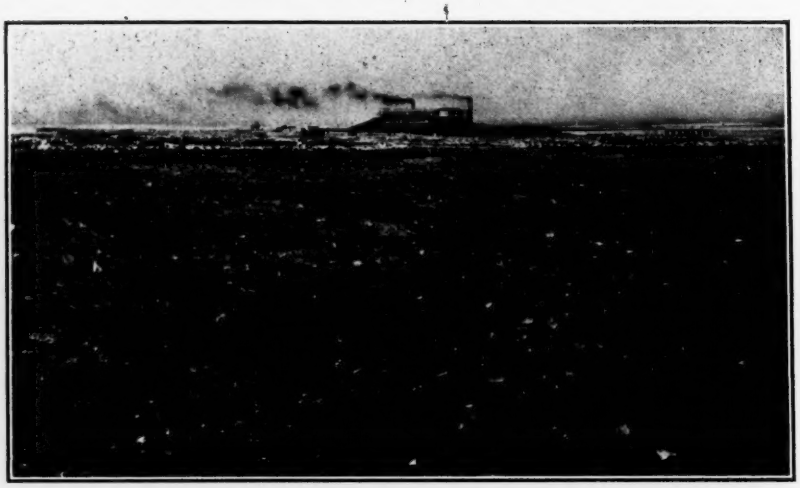


In a cutting which shows the layer of caliche with almost no overlying material. The tools shown are the only ones needed in mining caliche.

ing of these nitrates. Fertilizers were then quite unheard of in most places; industrial uses of nitric acid and its compounds were few; and for making explosives—then gunpowder was the only one—small, scattered deposits of true saltpeter provided the raw material.

Nearly a hundred years ago, it is said, a Scotchman living near Iquique spread over part of his garden some soil containing white crystals. That part of his garden flourished much more than the rest. Thereupon samples of the soil were sent to Scotland for experiments which revealed the nature of the substance and its fertilizing value; and thus, so the story goes, the foundation was laid for the great nitrate industry. A decade later, or about 1826, a Frenchman is credited with having established the first real nitrate works in the pampa back of Iquique. Soon after that an Englishman, a German and a Chilean are supposed to have followed suit, and the business began to grow slowly. A little more than 8,300 tons of nitrate are said to have been exported in 1830.

The nitrate fields then were divided among three countries. Peru owned Tacna and Tarapacá. Bolivia owned most of what is now Antofagasta, while Chile owned from Atacama southward. This last region was then not known to contain nitrate, and still is the least important part of the fields. Peruvians and Chileans became most active in the industry, perhaps because the fields were more easily reached from Peru and Chile than from the highlands of Bolivia. The Chileans turned their attention largely to the Bolivian province of Antofagasta, where their influence became so marked that it is said not more than one person in twenty was a Bolivian, and that one probably an officer in the army. Important concessions were granted by Bolivia to Chilean inter-

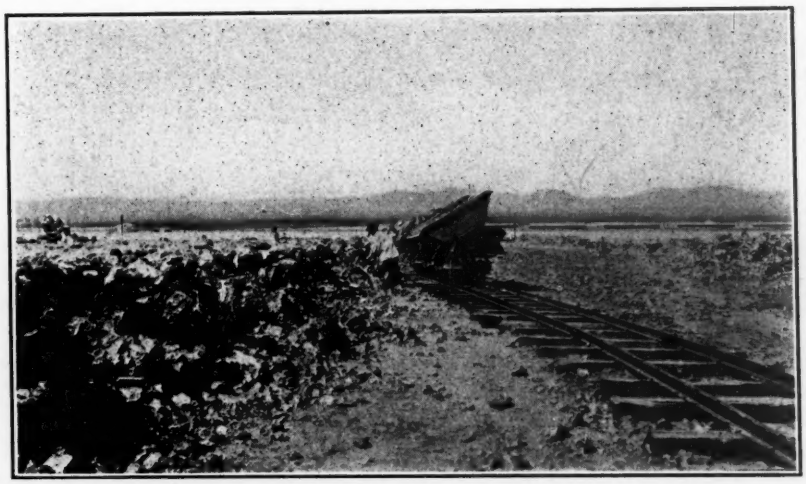


General view of an *oficina* and its surroundings. In the foreground is rich nitrate land. The white in the distance is a *salar*, where no caliche has been found.

ests, and in 1874, in return for the cancellation of a debt owed Chile, Bolivia agreed not to impose any export tax on nitrate for twenty-five years. Four years later, however, attempts were made to levy a tax of ten cents per 100 pounds on all nitrate exported. When the Chilean companies refused to pay the tax, the Bolivian authorities seized their property and declared that it would be sold. Chile was forced to step in to protect the interests of her citizens. Since Bolivia had entered some years earlier into a treaty with Peru against Chile, Peru also was dragged into the quarrel, the result of which was the beginning of war by Chile against both Peru and Bolivia in 1879.

It was an epoch-making conflict in which Chilean naval successes against Peru were largely responsible for the outcome. The treaty of peace, signed in 1883 found Bolivia driven out of her seacoast province, Peru deprived of her nitrate lands, and the Chilean boundary pushed more than four hundred miles northward. In some quarters the impression is common that the treaty provided for a return of the nitrate areas to Peru, if after ten years the people of the region should so vote. Such a provision was applied to the province of Tacna, and has been ignored by Chile, but Tarapacá, with its great nitrate resources, was handed over "forever and unconditionally" (perpetua é incondicionalmente). It was predicted then that possession of the nitrate lands would ruin Chile, as guano and nitrate were believed to have ruined Peru, but this gloomy forecast has not been verified.

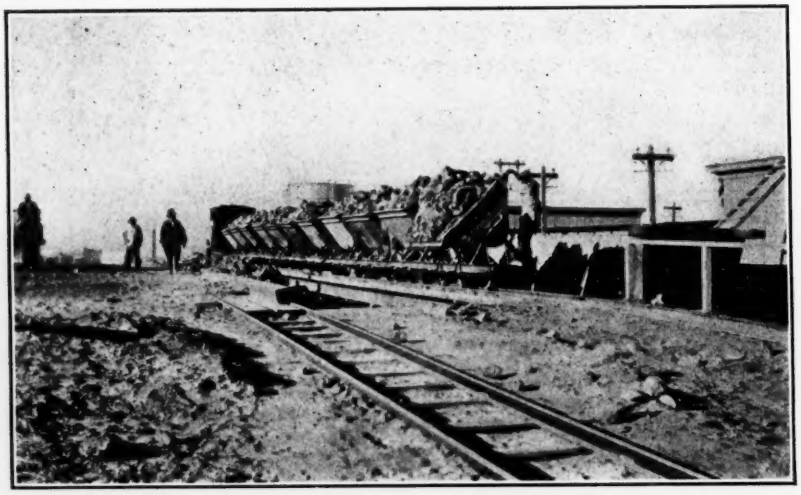
Since the war, and especially in the last fifteen years, a number of things have led to great progress in the nitrate industry. Foreign capital, English, German, Belgian, French, Austrian, and some from this country, has been added to the large investments made by Chileans. Thus more than £20,000,000 of English capital alone is tied up in



Loading caliche to be taken to the *maquina*. Piles of caliche at the left. The "camp," or laborers' quarters, of a neighboring *oficina* lies in the right background.

this business. Methods of manufacture have been improved, and the scale of operations has been increased greatly. New railroads have been built and old ones extended, until now there are about 2,000 miles of railroads, most of which have no other use than to serve the nitrate trade. But perhaps most important of all has been the vigorous campaign to advertise the merits of nitrate as a fertilizer. Tests have proved that nitrates are about the most effective fertilizer known for such crops as vegetables, sugar beets, and some of the cereals. To help increase the demand for this use particularly, representatives are maintained in every important agricultural region by the Chilean Nitrate Committee, and advertisements which are a part of this propaganda appear in agricultural journals in all parts of the world. Importations by the United Kingdom, Germany and the United States have been and still are increasing rapidly, while smaller amounts go to widely scattered markets.

The exports of nitrates in 1830 are said to have been about 8,300 tons. At the time of the Peruvian War, fifty years later, the amount had increased to 226,000 tons yearly—or less than the amount that two establishments might turn out now. Since 1880 the exports have reached enormous proportions. The million-ton mark was passed in 1890; almost a million and a half tons were shipped in 1900; and in 1911 the exports were but little short of two and a half million tons. To take care of this greatly increased demand, plant after plant has been built, until now more than 100 are in operation, several of which can produce in a month more than the whole exportation amounted to in 1830. Lands which were offered for sale a dozen years ago could not now be bought for ten times the figure quoted then. Shares of stock



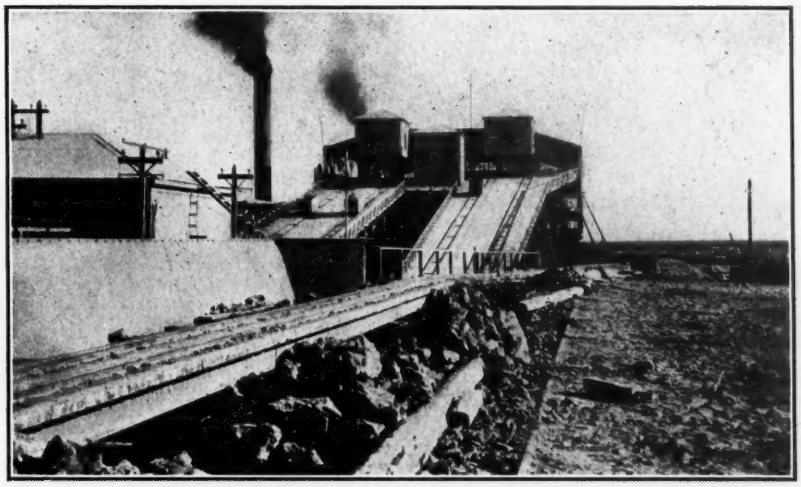
Dumping the caliche into the hoppers of the crushing machinery. Capacity of each car is about three tons.

of a par value of 25 pesos[1] not infrequently have paid annual dividends of 20 pesos, and stock dividends of 100 to 200 per cent. are not unknown. Under such conditions it is not strange that plants costing 5,000,000 pesos or more have paid for themselves in two or three years, and that nitrate shares are quoted at many times the amounts of paid-in capital which they represent. Thus in May, 1912, some quotations in Valparaiso were as follows:

Name of Company	Capital Paid in Per Share	Sales at
Agua Santa	10 pesos	340 pesos
Antofagasta	25 "	180 "
Boquete	5 "	130 "
Loa	1 "	67 "

Yet with all this enormous growth and prosperity, the process of production still is almost as simple as when the industry began. The first step is to make a hole about six to ten inches in diameter through the layer of caliche. Generally this is done with a chisel-edged, steel-pointed crowbar, or *barra,* the débris being removed from the hole with a home-made spoon-like affair, the *cuchara.* The bottom of the hole is enlarged so that a charge of powder may be put under the caliche. Most of the powder is made locally from nitrate, charcoal or coal dust and sulphur, for here it is so dry that the nitrate can not absorb enough water to make it unfit for powder. The explosion of the charge, the *tiro,* heaves up the caliche, commonly in blocks which must be broken

[1] Unless stated otherwise all money values are expressed in Chilean pesos, paper currency, at the rate of 1 peso equals about 21 cents in United States money.



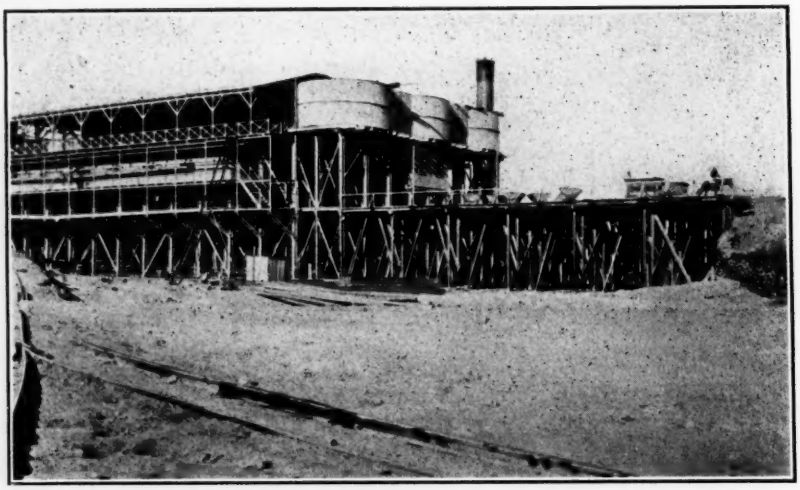
Cars of caliche, after crushing, going up the inclined planes to the *maquina*. Empty car comes down as full car goes up.

into smaller pieces with a heavy hammer. This is the process of nitrate mining. No operation could be simpler.

If the miner works by the day, he is known as a *barretero*, literally a "crowbar man." If he is paid according to the amount of caliche mined, as the most energetic prefer to do, he is a *particular*, or private worker. The former earns about 6 pesos to 7 pesos a day, while the latter, under favorable conditions, often makes 9 pesos to 12 pesos a day. A group of *particulares*, working early and late, quickly dispels any idea that no people of that part of the world will work hard.

Carts or trains of small dumping cars carry the caliche to the *maquina*, as the refining plant is called. Here it is first crushed into pieces no larger than a man's fist. From the crushers it goes up inclined planes to the boiling tanks, or *cachuchos* as they are still known, though earthen pots have been replaced by great iron affairs 32 feet long, 9 feet wide and 8 feet deep, capable of holding 70 tons. The newest maquinas have twenty to thirty of these tanks. When the charge of caliche is in, water is added, steam is turned into a coil of pipes which runs around inside the tanks, and the boiling process begins to dissolve out the soluble nitrates from the insoluble and worthless earthy substances. Thus the industry, which in one respect owes its existence to absence of water, must have water in order to operate, for nowhere are there large amounts of caliche rich enough to ship without refining, and the process of leaching is the only economical method of refining.

Much Australian and English coal, costing 35 pesos to 50 pesos or more per ton, is used to generate the steam. About half a million tons of coal have been imported for this purpose in recent years; but the



The *maquina*, showing the ends of the *cachuchos*, at the left of the ladder; the tanks for water; and at the right a mule car carrying away the *ripio*.

possibility of substituting California petroleum, already used to some extent, is being considered seriously by many operators.

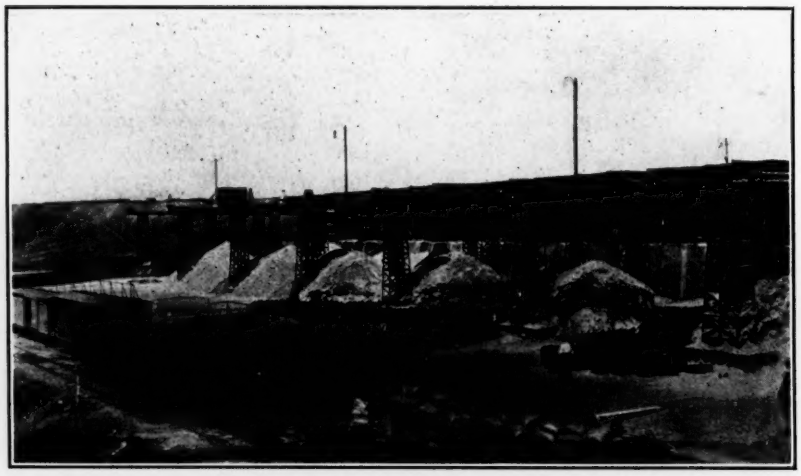
To get water for the maquinas is not everywhere easy, for the water supply always has been the chief problem in this region. Seacoast towns for a long time depended on supplies brought by vessels from four or five hundred miles farther south. It is interesting to note here that one of the prominent figures in the development of the industry after 1880 was an English iron worker, who is said to have come out to Chile to work on the tanks or boilers of some of these water-carrying vessels, and who later went home a "nitrate millionaire." The first railroads had trouble getting water for their engines, some resorting to the distillation of salt water, but now, for the railroads and the chief cities and towns, piping of water 100 to 200 miles from the Andine streams has relieved the situation greatly. Water, however, still must be used sparingly and almost everywhere the poorer people buy it by the pailful, a discarded kerosene tin generally serving as a pail. A common price is 10 centavos (=2 cents) for five gallons. In the pampa, wells yield a good deal of water, commonly more or less salty, but this source can not be counted on everywhere. Thus in central Antofagasta one plant secures more than 35,000 gallons of water daily from three wells, the deepest of which is less than 100 feet, but another plant, less than a mile away, found no underground water after spending 250,000 pesos in the attempt.

After the water in the cachuchos has boiled for several hours, it is passed to another tank where it encounters fresh caliche, and so on, until a saturated solution known as *caldo*, or broth, eventually is secured. When this point is reached the water is run off to a series of

The crystallizing tanks. Refined nitrate in the tanks in the foreground; tanks recently filled with *caldo* in the background.

tanks, known as *chulladores*, where the use of wheat flour, stable manure, or other substances, causes the precipitation of the miscellaneous soluble impurities, except ordinary salt, which have been dissolved out with the nitrate. From this purification process the solution goes to the crystallizing tanks, or *bateas*, which are placed ten or twelve feet above the ground to permit free circulation of air and promote cooling and evaporation. Thus dryness which figures in the origin and preservation of the caliche also has an equally great value in the process of manufacture. As the solution cools and the water evaporates, the nitrate begins to crystallize on the surface, so a "stirring boy," or *rayandero*, is employed to break up the film and make it settle. Five or six days are necessary to complete the crystallizing process. A large plant may have 300 or more bateas, capable of holding more than 1,000,000 gallons of caldo, and yielding at each full charge as much as 2,500 tons of nitrate.

When crystallization has gone as far as it will, a valve in the bottom of the batea is opened and the liquid is drawn off, leaving behind a thick layer of glistening white crystals. This is the nitrate or *salitre* of commerce, being 95 per cent. or more of pure nitrate of soda; the remainder is largely water and salt. The liquid which is drawn off, known as *agua vieja*, or mother liquor, still contains a large amount of nitrate in solution, and is used over and over again in the boiling tanks. In fact, no water is ever thrown away, the only loss being that which passes into steam from the boiling tanks and evaporates from the crys-



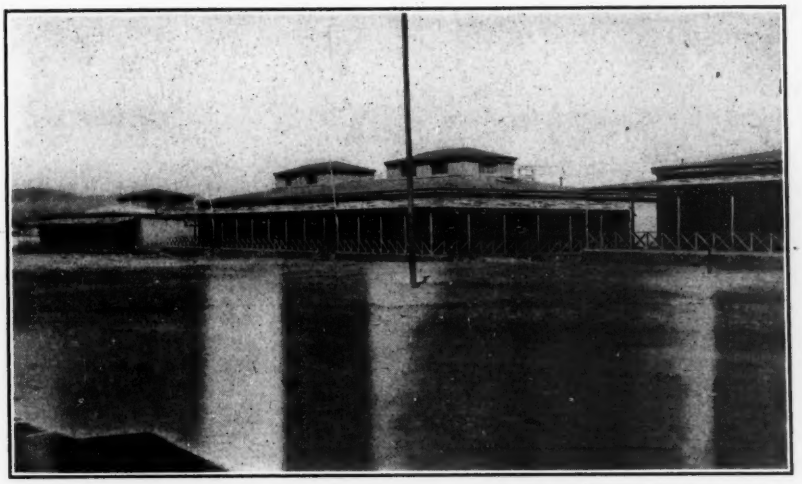
Photograph loaned by Mr. C. E. Atwood, Antofagasta, Chile.

Nitrate in the *cancha,* being bagged and put on cars for shipment. In the left background, a big accumulation of *ripio.*

tallizing pans. The finished nitrate is shoveled from the bateas into cars, drawn to the deposit, or *cancha,* and there after drying for several days is bagged ready for shipment. Shipment in bulk is impracticable because the nitrate so readily absorbs water. Even when shipped in sacks it sometimes becomes caked in the holds of ships and has to be taken out with picks.

From the agua vieja, iodine is extracted by a simple process of precipitation with chemicals (mainly sodium sulphites). It figures only as an important by-product of the industry, for the "iodine trust" makes an annual allotment to each establishment, commonly less than what could be made in a month, if there were no restrictions on production.

The only other important step in the refining of nitrate is the clearing and recharging of the boiling tanks. First, fresh water is run through to take out what it will of the remaining nitrate, this water being used subsequently, with aqua vieja, in the boiling process, for the more nitrate in solution at the outset the easier it is to get a saturated caldo. After the washing is over, a trap in the bottom of the tank is opened and the waste, or *ripio,* is removed. This process is the most bothersome in the industry, because for each charge of 70 tons of caliche, 50 tons or more of ripio must be removed. It is very hard on the men who work in the steaming hot tanks, and the disposal of the waste after it is removed, not uncommonly 1,000 to 2,000 tons a day, soon comes to be a problem. None of the operators succeed in getting much more than 75 per cent. of the nitrate originally in the caliche, hence ripio commonly contains 4 to 10 per cent. of nitrate, and the great piles con-

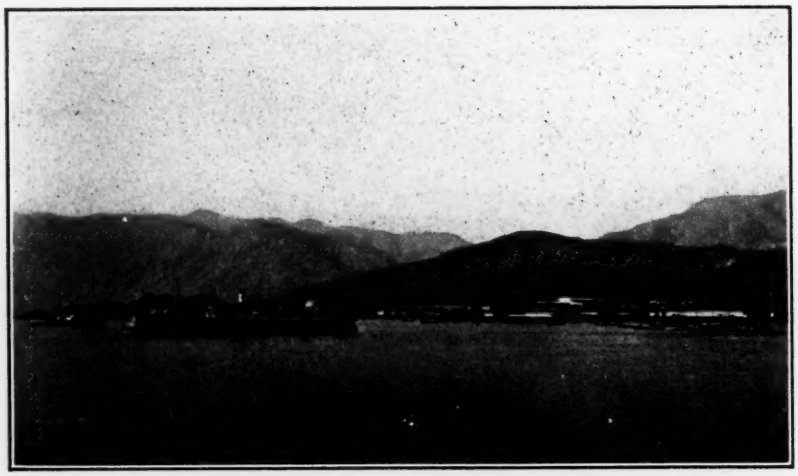


Residences of the manager and his assistants, from the "plaza."

taining millions of tons of waste some time may be reworked if conditions in the industry should make economies necessary.

A good deal of capital is needed now to start the nitrate business on a large scale. Many of the older *oficinas,* as the establishments are called, are small, representing an investment of not more than 25,000 pesos to 50,000 pesos. But a large modern plant may cost 6,000,000 pesos or more. For this reason the industry tends to remain in the hands of companies, about 80 in number, of which a few large ones really dominate the industry. In all there are about 160 oficinas in existence, English, Chilean, Austrian, German, etc., but for one reason or another not all of them are being operated. Exhaustion of the supply of caliche is the most common reason; for as a general rule an oficina is built for a given tract of nitrate land, with the idea of abandoning the oficina when that supply is exhausted. It does not pay to haul caliche any considerable distance, for a ton of average caliche will yield only about 30 pesos' worth of nitrate, on which the profits may be 10 pesos. There are only one or two "Yanqui" oficinas, the "powder trust" being interested in at least one of these. United States capital invested in western South America seems to have been attracted more strongly by other kinds of mining.

A modern oficina, like the Aníbal Pinto, in central Antofagasta, running twenty-four hours at full capacity, may have a daily output of 5,000 Spanish quintals (quintal = 101 pounds) of nitrate. The cost of production in May, 1912, at this plant, was stated to be about 2.50 pesos per quintal, covering everything up to the time of shipment. To this figure must be added the transportation charges to the vessel in Antofagasta harbor, about 1 peso per quintal, and the export duty of 2.50 pesos per quintal, making total costs on board vessel 6 pesos per



Part of Taltal harbor and city, with typical appearance of Coast Mountains.

quintal. At that time the selling price, on board ship, was 7.50 pesos to 8 pesos per quintal. Under favorable conditions, therefore, this oficina could market about 2,000,000 quintals a year, with profits amounting to 4,000,000 pesos. This particular oficina cost more than 6,000,000 pesos, but with the trade good, it would pay for itself in two years and give annual dividends of 10 per cent. at the same time. About five and a half square miles of nitrate lands have been set aside for the Pinto, a supply calculated to keep it going for twenty years, in most of which time the plant has nothing to do except pay dividends. The making of nitrate millionaires, therefore, is easy to understand.

The construction of a modern oficina uses supplies from widely separated places. Most of the buildings are of corrugated iron, for it withstands the intense dryness better than wood does. It commonly comes from Europe. The timber which is used is likely to be Oregon pine, for it is strong, durable and about as cheap as the Chilean product. German steel for tanks, cement from the United States, boilers from England, Belgian locomotives to haul the tiny cars and United States electrical equipment are found at one oficina.

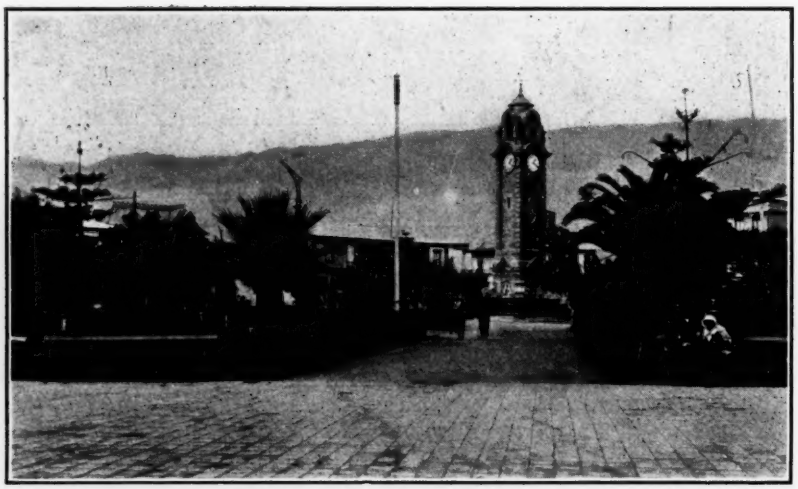
Most of the laborers are Chileans, Peruvians and Bolivians, attracted there by the higher wages than are to be had elsewhere in most other pursuits. In fact, the complaint is often made that the nitrate industry has retarded development of other activities in Chile, especially greater agricultural progress in the south, by absorbing not only the capital, but the labor as well. About 40,000 persons are said to be employed directly in the oficinas, some of the larger of which have more than 1,000 hands each. Wages run from about 3 pesos to 4 pesos per day for boys and 6 pesos per day for the poorest paid men, up to as high as 15 pesos for some of the men working in the maquina. Per-

Shipping in the harbor at Antofagasta. Note the line of surf.

haps 10 pesos is a fair average for the majority. Houses are provided by the company, but heat, light and water must be paid for by all except salaried employes. This latter class, including the manager, or *administrador,* and his subordinates, the engineer, bookkeeper, chemist, electrical expert, etc., are given their quarters, heat, light *and water,* in addition to salaries that range from 1,000 pesos up to 4,000 pesos a month.

Though wages and salaries appear high in units of currency, the prices of food stuffs also are necessarily high, since next to nothing can be raised anywhere in the nitrate region. Some prices charged in company stores are as follows: flour, 20 pesos per quintal; beans, 30 pesos per sack of about one bushel; eggs, 6 pesos a dozen; coal, 6 pesos for about 100 pounds. Only canned milk can be had, for there is no way of keeping cattle in this barren land. All cuts of meat are 50 cents per pound, and the rule of "first come, first choice" results in the formation of a "meat line" early every morning. A good many of the cattle used here come overland from Argentina. Kerosene from the United States costs about 1 peso a gallon, but the tin in which it comes also must be considered, since it serves a multitude of uses from waterpail to roofing material and baking oven. Potatoes are commonly sold by the half *robo,* which equals about a half bushel, but the natives are fond of explaining, with a significant gesture, that *robo* also means robbery.

The laborers generally are paid not in money, but in *features,* discs resembling poker chips and bearing the company name, together with the equivalent value in actual currency. These features are used almost solely at the company stores, but if any workman desires his wages in money he may draw at any time all that is due him. For the salaried

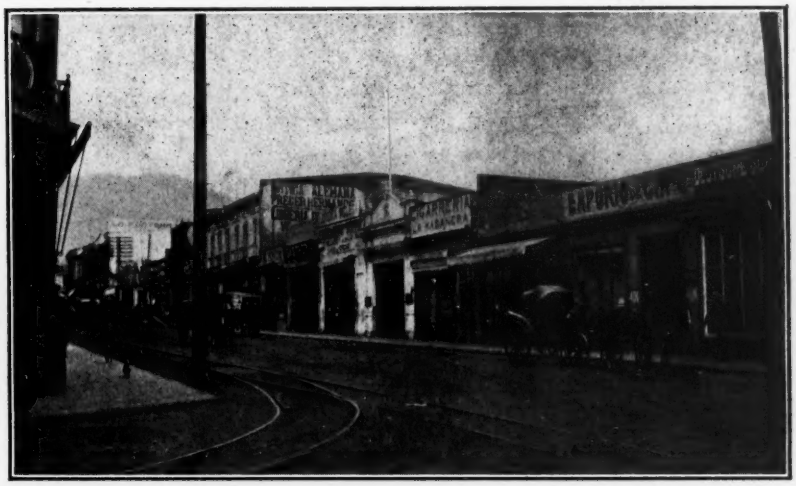


The plaza of Antofagasta, with the barren Coast Mountains in the distance. The clock tower was the gift of English residents on the centenary of Chilean independence.

employees, the pampa looks like a good place to save money, since food is about the only thing he cares to buy in the local stores. Some of the larger coast towns have fairly good stores, but Valparaiso is the nearest real "spending place," and to get there takes four days to a week. The mail-order business, however, is said to thrive here mainly because of these very conditions, with disastrous results to th[illegible]ing habit.

Large oficinas, with their many hands and the[illegible]ilies, may make communities of 2,000 to 3,000 persons. Schools are [illegible]rovided by the government, the teachers getting 150 pesos to 200 pesos per month, to which some companies add 100 pesos or more, in addition to the customary free quarters, heat and water. Priests and physicians make regular visits. Musical and social clubs are organized; bands give open-air concerts two or three times a week, and worse music may be heard in many more favored parts of the world. Football is a favorite sport and there is keen rivalry between teams representing neighboring oficinas. There is the inevitable biograph, a dance hall, annual visits by a circus, a saloon and even a gambling house, for since the men will gamble anyway, it is deemed best to have it done where some control may be exerted over it. Little trouble ever arises, for the resident manager is in some ways a local czar, with the very efficient mounted police of the pampa to assist in keeping order.

It is sometimes claimed that the laborers are exploited outrageously by the companies; that two prices are the rule in the company stores, the higher price always being for the laborers; that buying outside is almost or quite impossible; that they are assessed for medical service which they never need, and so on. It is also pointed out that although provided with houses, the living conditions among the laborers are



The main street of Antofagasta, from the corner of the plaza.

decidedly primitive, especially as regards sanitary arrangements. It is quite true that the camp commonly is placed where the wind will not carry the odors to the houses occupied by the manager and his subordinates. But in the bright sun and dry air of the desert, most disease germs do not thrive, and there filth, unpleasant as it may be, does not lead to the sickness which it might cause elsewhere. In order to get some return from the monthly assessment of a peso for doctor's services, so it is said, the people commonly feign illness, until the free medicine is received, whereupon the medicine promptly is thrown away. There probably is some truth in all the claims that the lot of the nitrate workers is not everything which could be desired, yet it is undeniable that they are better off than a good many of their own countrymen who are working elsewhere.

Living in the nitrate pampa has some compensations, as in the feelings inspired by the desert and especially in the beauty of its nights, but not even the mighty Pacific can lend charm to the seaports which act as middlemen between the oficinas and the outside world. Iquique, Antofagasta, Taltal, Chañaral, Mejillones, Pisagua and Tocopilla, ranging in population from 50,000 down to 5,000, suggest mining towns of our far west in varying early stages of evolution. Some of the foreign residents profess to find enjoyment there, as in a morning plunge in the ocean and a brisk canter along the beach, and with the clubs later in the day, but all too commonly the pleasures take the form of hard drinking as the only way of varying the painful monotony of existence. Iquique, the largest, generally is regarded as somewhat better than the others, but one who visits the others first is comforted mainly by the feeling that it must be hard to find anything worse.

A picture of one of these ports does almost equally well for all the

others. A crescentic indentation in the coast is called the harbor, for want of any other name. All vessels must anchor far out, owing to shallow water, the presence of reefs, or entire lack of docks. Cargoes are lightered to and from shore, while passengers run the gauntlet of the boatmen, or *fleteros,* and the surf, both of which at times are rather unpleasant. Protection for the vessels is poor in most cases, but fortunately storms are not frequent along this coast. Around the harbor, barren, colorless mountains rise to heights of 2,000 feet or more, and at their base lies a featureless town sprawled over a narrow, flat or sloping shelf. Within the town, wide, unpaved, dusty streets are lined with frame houses in varying degrees of dilapidation. Here and there one may catch a glimpse of some carefully watered plants or even a tiny patch of grass in a private "garden," and the main plaza of the town is sure to have some highly prized and proudly exhibited palms and other plants. But for the most part there is nothing to relieve the impression of dinginess and dejectedness that hovers over the place. Dirty hotels are crowded with patrons of a dozen nationalities, for all who come and go must use the only accommodations offered. For a time, the busy waterfront, and perhaps seals in the harbor, prove interesting, but even these quickly prove boresome, since every lighter piled with sacks of nitrate is like every other lighter, and after the seals have bobbed up a few hundred times, only to disappear as often, it ceases to be a novelty. Waiting for a steamer, the only means of escape from these ports makes one wish he had staid in the pampas, where the world seems big and less forlorn.

Ships of many nations come to carry away the nitrate, while many coastwise vessels bring supplies from the fertile valleys farther south. Nearly half the oficinas operating in 1912 shipped their product through Iquique, giving this port more nitrate traffic than is carried on by any other two ports combined. Antofagasta and Tocopilla are next in order. The value of nitrate exports is more than 70 per cent. of the total value of Chilean exports, and its tonnage is as great as that of any other South American export. As the nitrate goes out, the Chilean government levies an export duty, just as Bolivia tried to do when Chile took up arms on that account. The export duty sometimes is regarded as a device for checking overproduction, whereas it is simply an effective means of raising revenue for the national treasury. For a long time nitrate duties and proceeds of sales of nitrate lands have amounted to more than half, and in some years to not less than 85 per cent., of the total national income. These revenues alone represent more than ten dollars per capita or as much as the United States government spends from all sources of income. It is easy to see, therefore, why Chile often is charged with extravagance. Yet large sums have been employed wisely in the building of state railroads; something has

been done, and much more is now being undertaken, to improve port facilities, especially at Valparaiso; and much of the money has been used in building up an army and navy to insure Chilean leadership and prestige among the West Coast countries. It is estimated that in the thirty years following 1880 the total revenue from nitrate duties has been more than $300,000,000 (United States gold), while with the present rate of production and the same tax continued, the next twenty-five years will give Chile nearly $750,000,000 (United States gold) more.

One check on overproduction may be exerted through a law providing that government nitrate lands are open to exploitation only after such lands have been disposed of at public auction. But, at the same time, this law has tended to check individual effort in exploring thoroughly the limits of the nitrate deposits. Another check on overproduction has been the "nitrate trust," or *Combinación Salitrera,* an agreement, entered into in 1901 by the larger companies, concerning the limitation of annual output and its allotment among the different oficinas. For a number of years prior to 1909 the trust worked well, but since then, despite all efforts to keep them in line, a good many companies have limited their output only by the maximum capacity of their oficinas. As an official of one of the largest Chilean companies aptly said: "There is no need for agreements when the demand is so heavy and the prices so good. If the price goes down—well, perhaps agreements can be revived then."

The nitrate business is so vital to the northern provinces of Chile, and even to the whole country as it is now organized, that the future of the industry has been a question of much concern. Some believe that the opening of the Panama Canal, with the resulting shortening of voyages from Iquique and Antofagasta to the United States, United Kingdom and Germany, will stimulate the commerce in nitrate very materially, for those three countries now take about 80 per cent. of the exports. Optimistic prophets, noting also the increasing popularity of nitrates, forecast a new era of greater prosperity than ever before. The more pessimistic, on the contrary, foresee the speedy exhaustion of the nitrate supplies and a crisis for Chile unless adequate preparation is made for the inevitable readjustment.

Most estimates of the available supplies of nitrate range between about 70,000,000 and 100,000,000 tons, which at the present rate of production would insure the life of the industry for thirty-five to forty years. Some estimates, however, place the amount as high as 200,000,000 tons. The totals given are about equally divided between Tarapacá and Tacna on the one hand, and Antofagasta and Atacama on the other. Private lands, however, are estimated as covering more than half the total, though it must be remembered that the state lands are less well

known. The smaller estimates make little or no allowance for discoveries of new nitrate deposits, which is quite likely to happen, nor do they count on any improvements in processes of manufacture, which very readily might prolong by many years the duration of supplies now known. It also is possible that ripio, nitrate-bearing costra and low-grade caliche, thrown aside in the past, may be worked profitably in the future. Should all these things develop favorably, the nitrate industry could thrive for a good many decades to come. Otherwise its span of existence is not likely to extend much beyond the middle of the century, for increased production, which is entirely probable, must hasten the end.

Another possible "rock ahead" for the business has been found by some people in the production of nitrates from atmospheric nitrogen by an electrical process. Where water power is abundant and cheap, nitrates from this process can be made to compete with the Chilean product. It is being done now in Norway. But for most parts of the world which have large water-power resources the use of this power will be more valuable for other purposes as long as Chilean nitrates continue to be abundant and reasonably cheap.

It has been suggested that when the nitrate is exhausted irrigation may turn the pampa into a highly productive farming region. This may be possible for limited areas, but from what is known of the water supplies available it seems unsafe to look for any extensive agricultural development. Exhaustion of the nitrate apparently means a general decay of the region unless other mineral resources are discovered and developed. It means for Chile the loss of $100,000,000 (United States gold) in annual exports and $30,000,000 (United States gold) of government revenue. For the world it means turning to some other source of nitrogen for supplies to fertilize its crops. Happily the way already is open for the latter change.

THE POWER OF GROWTH IN PLANTS

By GEORGE E. STONE

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IT has been a matter of more or less common observation from time immemorial that plants possess the power to overcome obstacles. Some species of trees are not particular where they grow if there is enough soil and moisture, their roots often seeking places where apparently insurmountable obstacles must be overcome. In spite of the doubt often expressed, there are on record many cases of trees lifting large weights; and in mountainous regions large boulders are often found displaced by roots growing among them. Some trees even lift themselves slightly from their original positions into the air, as is evident from the location of the root buttresses, which are often found exposed above the surface, sometimes for a considerable distance. An instance is known of a tree growing in the center of a millstone, which later completely filled the hole and actually raised the stone from the ground.

Brick and concrete sidewalks are often ruptured and curbings displaced by roots, due to their growth in diameter, and perhaps in some cases to the actual uplift of the tree trunk and roots. The writer has had under observation for many years a black birch (*Betula lenta* L.), one root of which has entered a fissure in a large boulder and is slowly but constantly lifting this enormous weight. The fissure is at an

FIG. 1. Showing large black birch (*Betula lenta* L.), one of whose roots is lifting an 18-ton boulder.

angle of about 15 degrees. The vertical diameter of the root where it enters is only 4 or 5 inches, while its lateral diameter, owing to compression, is 18 or 20 inches, or more.

Careful measurements and specific gravity determinations would indicate that the weight of the boulder is about 18 tons, and this is annually being lifted higher and higher by the root growing in the crack.

The roots of trees often penetrate, and, as they grow, displace the foundation walls of buildings. We recall an old, heavy-timbered

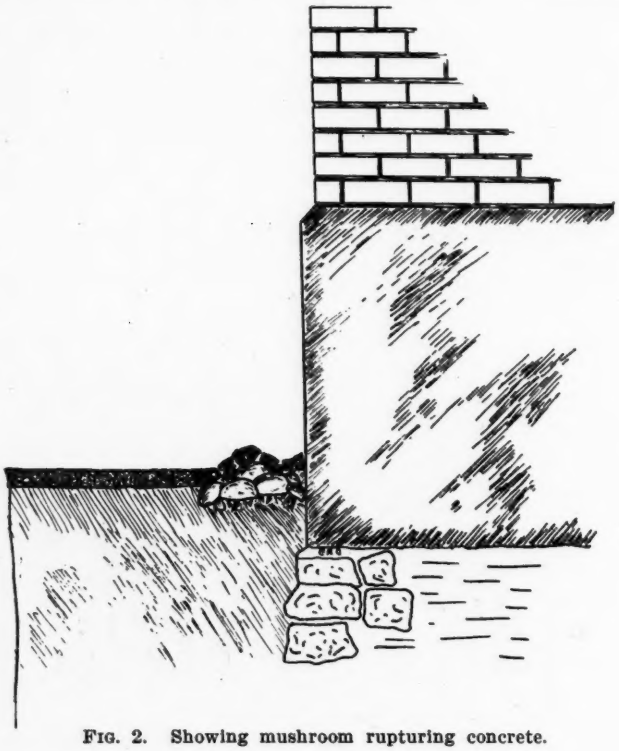

FIG. 2. Showing mushroom rupturing concrete.

colonial house which had one corner thrown considerably out of the vertical by the growth of tree roots under the foundation. In this case the roots must have lifted many tons in weight. In another instance a gentleman noticed that the stone in a walk leading to his residence had been displaced. He became alarmed and sent for the police, laboring under the impression that burglars were responsible for the displacement and were planning some deep plot against him. But on moving the stone, which weighed 80 pounds, three large mushrooms were discovered and the mischief was explained. Instances are known of mushrooms pushing up through hard tar walks two or three inches thick without the slightest difficulty or evidence of injury to their deli-

cate tissues; and even seedlings often displace comparatively large masses of soil in pushing up through.

For several years we have been observing the rupturing of very hard concrete by ostrich ferns (*Onoclea Struthiopteris* L.). The concrete, which is two and a half to three inches thick and composed of sand, tar and coarse gravel, acts as a watershed next a dwelling house. Along the edge ostrich ferns were some time ago planted in loam rich in organic matter, and have since been growing most luxuriantly, the stalks often reaching a height of six feet or more. Like most ferns, the underground stem or rhizome spreads out in all directions each year and thrusts up new fronds; and quite regardless of the apparently impenetrable covering, the rhizomes work their way under it and attempt to throw up new shoots. And not in vain, for the ferns appear to break through the concrete as easily as though it were so much putty. This rupturing occurs almost every spring when growth is active and the fronds unfolding. Sometimes the concrete is broken up where it joins the underpinning of the house and where it is more easily dislocated, and again the ferns come up through the middle.

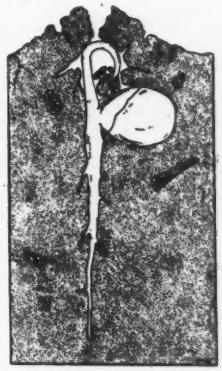

FIG. 3. Showing epicotyl of seedling bursting through the soil.

FIG. 4. Showing young fronds of ostrich ferns (*Onoclea Struthiopteris* L.) rupturing concrete.

The fronds which push themselves up through the concrete are necessarily more backward in unfolding than the unobstructed ones, although as a rule it requires only a week or ten days for them to break through. It required two years for one group of fronds to come through, though, as was evident from the constant upheaval of a part of the concrete one spring; but the next spring they succeeded in their attempt. The ease with which this breaking through is accomplished and the freedom of the ferns from scars and injuries are remarkable

when the solidity of the concrete and the force needed to rupture it are taken into consideration.

Being interested in this phenomenon, we endeavored to learn approximately the power required by the ferns to rupture the concrete. In the experiment, some of the soil underneath was first excavated and a lever arranged in such a way that force could be applied in practically the same manner as was done by the ferns, *i. e.*, a round piece of wood was placed on the end of the lever of the same dimensions as the undeveloped cluster of fern fronds. The fulcrum of the lever was one foot

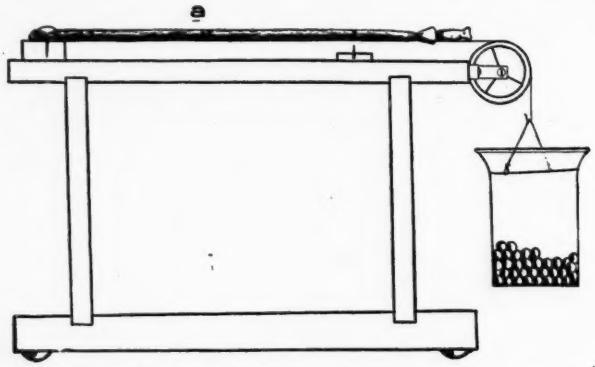

FIG. 5. Showing method of demonstrating power of growth. Growing flower stalk of tulip placed in 10 per cent. solution of potassium nitrate, which causes the stalk to shorten. The stalk is then stretched to its original length and the power of growth determined.

from the point of contact with the concrete, and weights were placed on the other end of the lever at different distances, as the case required. Our object in this test was to ascertain how long it would take to rupture the concrete and to determine the amount of weight necessary to do it. It was not intended to apply force enough to cause an immediate rupturing of the concrete, or even in a few hours, but in perhaps ten or fifteen days—the same length of time usually required by the ferns. A number of tests were made, care being taken to have all the conditions as nearly like those under which the concrete was broken by the ferns as possible. A weight of 699 pounds broke the concrete in a few hours. Next a weight of 262 pounds was applied, which required ten days, while in still another test a weight of 189 pounds broke through in thirteen days. Other tests were made, but it is not necessary to give them here. A weight of 189 pounds, therefore, seemed to rupture the concrete in about the same time as was done by the ferns; and in our estimation this test represents a fairly good duplication of the fern phenomenon. If we consider the average cross section area of the six fern fronds and divide this by the total weight lifted, we find that the cells of the young fronds exerted about 35 atmospheres to over-

come the resistance offered by the concrete. This we consider a very fair estimate, although from our other experiments we are led to believe that as high as 50 atmospheres are sometimes required to accomplish the work with the conditions under which the ferns were growing. The concrete was so hard that after it had been ruptured it was impossible to make any impression on the ragged edges except by the use of tools. The work was done by a slow and constantly increasing pressure on the under surface of the concrete, the principle being somewhat the same as in the straightening of teeth and bones, although in such cases the pressure is not increased.

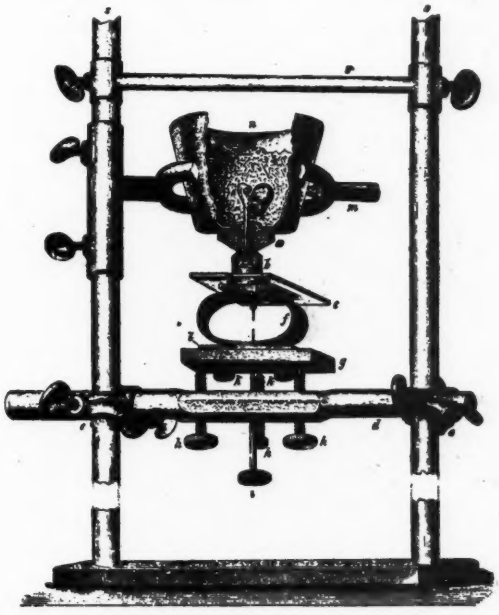

FIG. 6. Method of determining the longitudinal power of growth in roots. The roots are held firmly in two plaster of Paris casts, and the amount of pressure indicated by the spring. (After Pfeffer.)

At this point we might consider what growth is and how it is accomplished in a plant. Growth is defined as a stretching and fixation of the cell walls, accomplished by osmotic pressure characteristic of the solutions contained in the cell vacuole. In ordinary growth there is a pressure of 1 to 3 atmospheres on the cell walls—a fact which can be determined experimentally with some degree of accuracy. It is this pressure which gives plants their rigidity and freshness, and anything which destroys it, such as lack of water, causes the plant to wilt. Rapidly growing organisms—annuals and herbaceous plants, for instance—contain little mechanical or supportive tissue, and it is owing to the turgidity of the cells derived from osmotic pressure that they

are able to hold their leaves and other organs in position. This could not be done without the exertion of considerable pressure, for their delicately constructed leaves and other organs often assume positions requiring a great deal of support. In trees and shrubs there is a large amount of mechanical tissue which supplies the necessary means for supporting the various members.

What is termed the "power of growth" can be determined by learning the amount of weight required to stretch a rapidly growing stem to its original length after the turgidity of the cells has been destroyed by placing them in plasmolyzing solutions, such as a 10 per cent. solution of potassium nitrate. The mean area of a cross section of a stem in millimeters, divided by the amount of weight obtained in grams, gives the number of grams per square millimeter of surface, and, as previously stated, there is usually obtained by this method a pressure of one to three atmospheres or more in the cell for ordinary growth.

FIG. 7. Method of determining radial pressure of growing roots. (After Pfeffer.)

While this osmotic pressure is common in ordinary growing organs, it does not necessarily follow that it constitutes the limit, since in the case of the ostrich fern previously referred to it was much higher. When growth is mechanically restricted or the organism has obstacles to overcome, the cell turgescence or osmotic pressure may be greatly increased owing to the resulting stimulus, and this is what occurred in the case of the ferns.

If a cross section of a stem is made and the bark split vertically, a noticeable shrinkage of the bark takes place, demonstrating a difference in tension between the outer and inner tissues. On the other hand, if longitudinal slices are taken from the outside of a common sunflower stem, they will shorten from 1 to 4 per cent. of their length, while the tissues from the center of the stem (pith) will lengthen from 1 to 6 per cent. when removed. It is clear from these observations that the

various tissues of the plant are under tensions which may exhibit differences equal to 12 atmospheres or more. What is termed the "shearing stress" often becomes so great that the resistant cell walls are ruptured, a condition associated with great pressure in living cells. The injection of poisons into trees may likewise cause a rupturing of

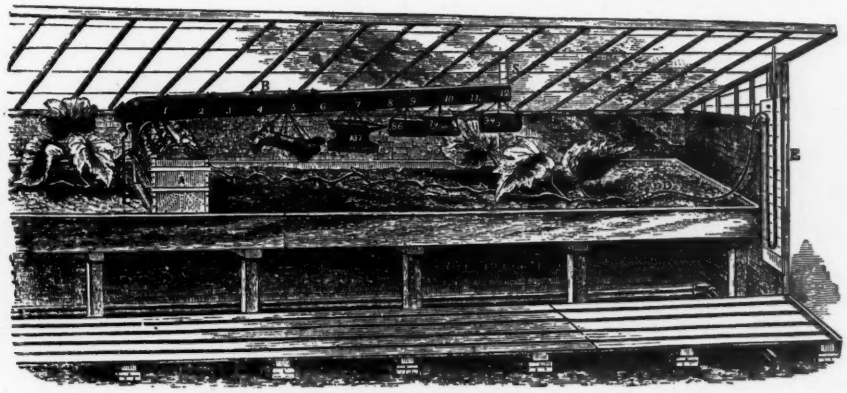

FIG. 8. Showing squash in harness. A weight of 5,000 pounds was lifted. (After Clark.)

the tissues owing to changes in the turgescence of the cells, and the splitting of melons in the field sometimes occurs from the absorption of an excessive amount of water into the inner cavity of the fruit. This increases the turgescence of the cells lining the cavity, and modifies the existing tissue tensions. The skin of the grape often cracks, possibly from the same cause.

It has been shown that the mechanical restriction of growth acts as a stimulus, inducing an increase in the osmotic pressure of the living cells, and in like manner, increased tensions may result in a much greater strength of the organism. It has been observed, for example, by Hegler, that a young sunflower seedling having an original breaking stress of 160 grams was able to maintain 250 grams after it had been stretched by a weight of 150 grams for two days, and later stretching of the stem by means of suspended weights over a pulley demonstrated that in a few days more its tensile strength was increased to 400 grams. This increase is correlated with thickness of the cell walls, a greater elasticity and the development of mechanical tissue.

The stimulation induced by the contact of tendrils and hook plants with objects is similar to that caused by stretching by weights. Experiments with the roots of various plants enclosed in plaster casts have shown large pressures. Pfeffer obtained osmotic pressures in the root cells of a common horse bean ranging from 5 to 19 atmospheres when the growth of the roots in length (longitudinal pressure) was

mechanically restrained by the use of plaster-of-Paris casts, and from 2 to 6 atmospheres for the radial pressure of roots. The geotropically sensitive nodes of the wheat stem gave a pressure equal to 15 atmospheres when mechanically restricted. The maximum osmotic pressure in these cases would be obtained by a solution of potassium nitrate equal to about 5 per cent.

Colonel W. S. Clark's experiment with the lifting power of a squash, made in 1874 at Amherst, was one of the first attempts to learn the growing power of plants. This experiment attracted quite a little

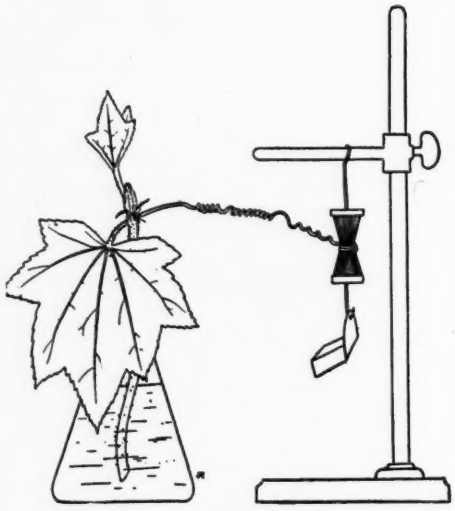

FIG. 9. Method of demonstrating clasping power of tendrils.

attention at the time. One highly respected minister of the gospel had a drawing of the harnessed squash distributed among his congregation in tract form to illustrate the great moral principle that "If God in his providence has given such enormous power to growing vegetation to overcome difficulties, how much more will he give to you power to overcome the difficulties that may be in the way of your reaching the true end of all living."

This experiment was carried on in a greenhouse under the most favorable conditions, and by arranging an iron harness provided with a lever attachment the squash was found to raise 5,000 pounds. The squash was horticulturally known as the Mammoth Yellow Chile variety, and at the close of the experiment weighed 47½ pounds. It is estimated that the squash developed over 80,000 feet, or about 15 miles of roots, an average of about 1,000 feet daily. From the data given in this experiment we have been able to estimate roughly the osmotic pressure of the cells, which might be supposed to be most active,

but we have been unable to find that more than 2½ atmospheres were involved. Professor Sachs, with the same data, estimated that the cell pressure developed was equivalent to a little more than one atmosphere.

Climbing and tendril-bearing plants, of which there are almost countless varieties, react to what is termed contact stimulation. Besides the many varieties which decorate our verandas and which are cultivated in our gardens for food, there are others with sensitive petioles (clematis and hook plant—*Uncaria*) which assist in anchoring the plant to supports. We have collected considerable data on the power displayed by tendrils and twining stems in clasping a support. Notwithstanding that the clasping results from the stimulation of the tendril, brought about by prolonged contact, the osmotic pressure does not ever appear to exceed the normal, only one to three atmospheres being found in these experiments. On the other hand, the effect of stimulation by contact in this case is to transmit the stimulus along the tendril, resulting in the formation of a spiral, and in most cases, if not all, the plant energy induced by the stimulus is directed towards the formation and modification of mechanical tissue, to render the union of the plant with the support more firm.

FIG. 10. Showing growth of tissue over street sign placed on tree. The growth is restricted only at one point. The sign acts as a constant stimulus, inducing the callus to grow over it.

The formation of mechanical tissue in a tendril is well illustrated in the tendril of the common grapevine, and in various hook climbers. At first the tendrils of the grapevine are quite delicate and even edible, but later they become extremely hard and wiry. It would manifestly be a waste of energy from the economic point of view for tendrils to develop excessive clasping strength by means of an increased cell turgescence or osmotic pressure, since the clasping strength resulting from the normal turgidity or osmotic pressure of the cells is sufficient to answer all requirements. On the other hand, the increased production of mechanical tissue or a modification in the elasticity of the tendril is obviously of great advantage to it from the biological point of view. What is true for tendril plants appears to be true for climbing plants, such as the bean, as well as of plants with sensitive petioles, since there is no loss of energy displayed in the development of a superfluous osmotic presure in the cells for the mere purpose of increasing its clasping powers.

THE ABSORPTION AND EMISSION CENTERS OF LIGHT AND HEAT.

By Dr. W. W. STRONG
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THE mechanical motions of nature are transmitted by solids and fluids from sources that consist of more or less well known mechanical systems. Waves on a pond may be due to a boat moving over the surface of the water. Sound waves in air may be due to the vibrations of a tuning fork. Wireless telegraph waves may be due to high frequency electromotive force and current waves in electrical circuits. In general the source of the above type of wave motion is a kind of mechanism that can be made in the laboratory or in the shop—a mechanism that is man-made and whose operation is quite obvious to us.

The phenomena of light and radiant heat introduce to us a type of wave motion that is altogether different. Not only may the medium that transmits this wave motion possess entirely different properties from that of matter, but the mechanisms that take part in the emission and the absorption of the wave motion are altogether different from any that we have been able to make in our laboratories. No one has succeeded in producing radiant heat, much less visible light and ultraviolet radiations by means of electromagnetic oscillators, although such a feat may be possible.

Inasmuch as matter is the source of all heat and light radiations, the mechanism responsible for the emission and absorption of these radiations must be intimately related to the nature and constitution of matter itself and therefore theories of emission and absorption systems depend to a large extent upon our theories of the nature of atoms and molecules. It must be remembered, however, that the nature and constitution of atoms and molecules that explain chemical and many other phenomena need not necessarily be at all related to the systems taking part in heat and light radiations.

In the past many different hypotheses have been advanced to extend the atomic and molecular conceptions of Dalton, Clausius, Maxwell and others. As long as the elastic solid theory of the ether prevailed, it was frequently assumed that the vibrating systems emitting light and radiant heat were of a mechanical nature due to the development of stresses and strains. The electromagnetic theory of Maxwell, while not even suggesting the nature of the mechanism, metamorphosed our views of radiant energy and indicated the whole phenomenon to be an electromagnetic one.

Black Body Radiations and Electron Atmospheres

Since the advent of the theories of liquid and gaseous ionization, many attempts have been made to construct a system composed of ions and electrons of various kinds that would be capable of explaining the phenomena of optics and radiant heat. In the case of black body or pure temperature radiations, the theory has been quite successful and seems to correctly describe the actual conditions. Solids or liquids are known to contain large numbers of electrons and when these bodies conduct metallically there is good reason to believe that the electrons move about in these bodies like gaseous molecules in a gas, the law of the equipartition of energy applying to an electron "gas" in a metal in the same way as it does to gases outside the metal. The emission of light and heat under these conditions is presumably due to the production of electromagnetic waves when the electrons are greatly accelerated or retarded in their motion. Laws of radiation like those of Wien and Planck can be derived from the conditions that would be expected to hold in an electron atmosphere. In this type of radiation the distribution of energy throughout the various wave lengths is practically independent of the kind of matter, but depends only upon the temperature and the nature of the electron atmosphere. Thus the radiation constants are universal constants depending upon one kind of radiating and absorbing system, the electron.

Selective Radiation and Absorption

Many sources of light and radiant heat emit radiations whose energy distribution over the various wave lengths is very different from that of a black body radiation. These radiations are selective and depend upon the nature of the body that is emitting or absorbing. Emission spectra illustrating this selective radiation are spark, arc, band and other spectra. Colored objects all show selective absorption. The problem of unraveling the constitution of the centers of selective radiation and absorption is a very difficult one and at present many efforts are being made to correlate the possible constitution of such centers with the ordinary molecular, atomic and ionic theories of matter. During recent years the trend of theory has been largely directed towards the view that emission and absorption spectra originate in systems that have a more or less momentary existence, owing to the fact that such optical systems are essentially dynamic in nature. It is very natural, therefore, that especial efforts should be made to find the existence of these momentary systems during periods of ionization and recombination of atoms, molecules, ions and electrons.

An Ideal of the Illuminating Engineer

The subject of selective emission and absorption is one of prime importance to the illuminating engineer. The rods and cones of the

retina are selective absorbers of light. Any illumination should, therefore, be tuned to this selective absorbing mechanism of the eye. Under these conditions the illumination will be most pleasing and there will be a minimum amount of energy used in the emission of the radiation used for illumination. Naturally this kind of radiation will be a "cold" radiation and not a temperature one. It is represented in nature by the light from glow worms and fireflies and in laboratories, approximately, by various kinds of phosphorescent materials, the source of such radiation being at room temperature.

Definition of Emission and Absorption Centers

The problem of finding the constitution of the emission and absorption centers of selective types of spectra such as those of phosphorescent substances, sparks, arcs, flames, etc., is a very difficult one, and at present many efforts are being made to correlate the possible constitution of such centers with the various molecular, atomic, ionic and electronic theories of matter. Emission and absorption centers of light and heat are the smallest particles or entities from which one can obtain any given characteristic emission or absorption spectrum. A further division or change of the centers will result in making it impossible for the given spectrum to be emitted or absorbed although the resultant particles or entities may possess a characteristic spectrum of their own. From the definition it is to be noticed that the centers need not necessarily be matter, *i. e.*, possess mass. When the centers move with reference to the observer, their spectral lines and bands will show the Döppler effect.

Light centers seem to be very complex in their nature. Professor Rowland used to compare them to a piano and the work of Professor Wood upon resonance and fluorescent spectra indicate that the analogy is quite an appropriate one. Strike a key, *i. e.*, excite a vapor like that of sodium with monochromatic light and a whole set of harmonics will be set into vibration. In the case of sodium vapor, each series of lines or bands seem to be due to vibrations of systems that may be quite independent of each other. Apparently there are a large number of these vibrating systems in the light centers of the fluorescent spectra of sodium. The center itself may correspond to the atom of sodium, though at the present time no definite evidence has been brought forward to prove that the center is even of atomic magnitude.

The Problem of Light and Heat Centers

In the study of light centers, attention must be directed for a moment to the many and serious difficulties connected with the problem of determining the nature and constitution of these particles or entities. The conditions under which they exist are very different from the conditions under which we study the other physical and chemical units of matter. Then again, it seems that light centers have a comparatively

enormous absorbing or emitting power, so that only a small part of the matter in a given region is concerned with the light and heat emitted or absorbed in the region. Light beams that are sufficiently intense to study are apparently emitted by a very large number of light centers and for this reason it has been found impossible to isolate individual centers; and even if this were possible it may be that the life of these centers is so short that even the isolation of centers would not permit their being studied. Then again, light emission is usually accompanied by many intricate phenomena such as ionization and chemical reactions and this adds to the complexity of the problem. When we consider our profound ignorance respecting even the nature of chemical forces, the constitution of the molecule and atom, the nature of the electric and magnetic fields and even the nature of light itself, it is not at all remarkable that little definite and certain knowledge has been obtained concerning the nature of light centers.

Some Methods of Approaching the Problem

There are several avenues of approaching the problem of the nature and constitution of light centers that seem to be extremely inviting.

1. At the present time a wonderful field is being opened concerning the dynamics of chemical reactions. As chemical reactions are intimately related to heat and light effects, the discoveries in this field are bound to give a great deal of information concerning light centers.

2. A study of the far infrared promises to break the gap between electromagnetic waves and radiant heat and light centers will probably be found to consist of molecular systems vibrating in a way similar to that of the sources of electromagnetic waves. At the present time we can compare light and heat centers with more or less well-known aggregates of matter and make as many identifications as possible.

3. The separation of complex line and band spectra into series of related lines or bands promises to give us a great deal of information ultimately as to the nature of the vibrating centers, although at present the problem is so complex that no one has been able to devise any mechanism or structure that is adequate to explain the known phenomena. The theory of Ritz has been one of the most successful so far advanced.

4. The Zeeman effect obtained by placing the heat and light centers in a magnetic field is important. This effect indicates that many of the centers of spectral lines consists of negative electrons.

5. The Humphreys-Mohler pressure shift of spectrum lines, the Döppler shift of lines and bands emitted by moving centers as studied by Stark and others, are also very important.

Possible Structure of Light and Heat Centers

One may picture light and heat centers as consisting in part as follows:

1. Neutral "aggregates" of charged particles possessing, in general, translatory and rotatory energy. When undisturbed from without these aggregates would have little if any external electric field. When the equilibrium of such a system is disturbed by collisions or by electromagnetic waves, it may possess temporary fields that will serve as the source of heat and light radiation. This radiation may be due to a rapid oscillatory motion that may be radial, transverse or tangential and would probably be characterized by a definite period. On account of the magnitude of the forces necessary for stable equilibrium, the period of the radiation would probably be small. The spectroscopic models of Thomson, Nagaoka and others are of this type.

2. "Aggregates" may possess charged parts; these may be so far apart from each other that local fields of considerable intensity may exist. If such an aggregate were to rotate, an alternating electric field would result and radiations would be emitted. This radiation, depending on a central acceleration, would vary in period with each impact, so that the various periods emitted would vary about a mean, which would depend on the average rotational energy before impact and the nature of the impact.

3. Freely charged particles torn from neutral "aggregates" will radiate energy when their velocity is changed. The quantity of this radiation will vary with the velocity and the acceleration. The breaking up of the neutral "aggregates" may be called ionization if the resulting parts are charged. Ionization processes may take place within molecules and this is believed to be the condition existing in many kinds of organic compounds when they absorb light or heat.

The relation between ionization and luminosity is not yet clear. Some physicists believe that the two are related to each other and that luminosity becomes perceptible when the intensity of ionization is sufficiently great. It has been stated that a gas may become luminous when one molecule in every $(10)^7$ is ionized. This would mean that the expenditure of about $(10)^{-5}$ ergs is necessary to excite luminosity.

Ionization and Light Emission and Absorption

There appears to be considerable evidence supporting the view that some band spectra such as those of bromine and iodine may be due to the dissociation of molecular systems or to a recombination of the dissociated parts. Ladenburg has found that luminous hydrogen gives an anomalous dispersion in the neighborhood of H_α, while this kind of dispersion is absent in ordinary hydrogen. The phenomena of dispersion indicate that different series of lines in a spectrum may be emitted by very different kinds of vibrating centers, while a particular center may emit only a single line of a series, depending on the manner of its excitation. Faintness in the intensity of lines may be due to the fact that there are very few light centers emitting the given line, or that the

vibrations have only a very small amplitude. Koenigsberger and Küpfur and others consider that the band spectra of iodine, bromine, nitrogen peroxide (N_2O_4), sulphur, iodine trichloride, nitrogen, etc., are due to a dissociation or recombination of the respective molecules, atoms or ions. In the case of iodine this change might be represented by the equation

$$I_2 \rightleftarrows I + I.$$

At about 800° C. this reaction is about complete and the fine-banded absorption spectra should therefore disappear. Galitzin, Wilip, Evans and others have shown that the bromine absorption spectrum disappears as dissociation becomes more and more complete.

Canal Rays

Canal rays have their source in positive ions that start in front of the cathode, move towards the cathode and pass through any openings in it with a velocity of about $(10)^8$ cms. per sec. After passing the cathode the canal ray particles may lose their charge or even become negatively charged. The spectrum lines of hydrogen, nitrogen, mercury, sodium, potassium, etc., emitted by canal rays show the Döppler effect when they are viewed in the direction in which the canal ray particles are moving. Accompanying the shifted lines are lines showing no displacement, "rest" lines due to centers that are comparatively at rest. The "rest" line is usually narrow while the shifted line, due to rapidly moving centers, is rather wide, the violet side of the line often being the sharpest. The width of the line indicates the range of velocity of the canal-ray emitting centers. Making certain assumptions as to the potential gradient through which the centers have passed, Stark has calculated the charge carried by centers emitting the various lines.

Since the "rest" and "shifted" lines are separated by a dark region, Stark concluded that canal-ray centers can only radiate line spectra when their velocity exceeds a certain critical value, this critical velocity increasing as the wave-length decreases. Increasing the purity of the gas increases the relative intensity of the "shifted" lines. Strosser has caused a stream of canal-ray centers to impinge into a current of a foreign gas. The lines of the foreign gas were found to increase in intensity on leaving the cathode, pass through a maximum and then decrease in intensity. The intensity of the lines of the canal-ray centers decreased in intensity as the distance from the cathode increased.

Carriers of Spark Spectra

Spark spectra have been photographed on rapidly-moving films by Schuster, Hemsalech, Schenck and others. The length of time the metallic vapor continued to emit line spectra was found to vary from

10 to $45(10)^{-6}$ secs., depending on the line. The velocity of the centers of Mg λ 4481 was found to be about $2.5(10)^5$ cm. per sec. near the electrodes, dropping to $1.7(10)^5$ cm. about a millimeter from the electrodes. Air line centers have an existence of about $7(10)^{-7}$ sec. The emission centers in flames and arcs have been studied by Lenard and others. The results obtained do not agree with those found by Stark working with canal rays.

Negative Electrons as Emission and Absorption Centers

The Zeeman effect produced by the action of a magnetic field upon the emission or absorption light centers shows that for many spectrum lines of gases and vapors the light center consists of a negative electron and the ratio of the charge to the mass of the electron obtained in this way agrees very well with the value obtained by other methods. The more accurate experiments give $e/m = 1.775$ while direct experiments give 1.772.

The Positive Electron

The positive electron has never been isolated in any experiment with vacuum-tube discharges, radiations from radioactive materials, etc. The Zeeman effect of certain band spectra of chlorides and fluorides of some of the alkaline earth elements studied by Dufour and of the absorption spectra of neodymium and erbium compounds as studied by Becquerel indicate the existence of positive electrons. These Zeeman effects may be explained, however, as being due to induced magnetic fields being set up in the region of the light centers, magnetic fields whose intensities are very different from the field impressed from without.

Absorption Centers of Solutions of the Rare Elements

Many solutions of salts of elements such as uranium, neodymium, erbium, somarium, etc., show a banded absorption spectrum. Many of these bands are very narrow. Jones, Anderson and the writer have found that the absorption centers of many of these salts (*e. g.*, uranous chloride) consist of centers containing the salt and an "atmosphere" of the solvent, the whole center apparently acting as a compound. Thus in the above case it is possible to have "water and alcohol centers" of uranous chloride in a solution of uranous chloride in water and alcohol. Increasing the amount of one solvent appears to increase the relative number of the centers of that solvent without apparently changing their composition. The different solvent centers have different degrees of persistency. The water and alcohol bands of neodymium chloride are of about equal intensity when the salt is dissolved in a solution containing about 3 per cent. water and 97 per cent. alcohol. Changes of temperature change the relative persistency of the light centers.

In the case of some uranyl salts the addition of free acid of the salt causes a shift of the bands. This has been explained by the writer as being due to the fact that the light centers consisted of "aggregates" of

salt and acid. Evidences of series of "aggregates" were obtained by spectrophotographs of chemical reactions, spectrograms of the absorption spectra of a solution of a given salt being taken as increasing amounts of some other kind of acid was added to the solution.

Centers of Phosphorescent Spectra

Lenard, Klatt, Urbain and others have studied the phosphorescence of various calcium phosphates of bismuth, manganese, nickel, etc. Lenard and Klatt have proposed the view that these light centers or "dynamids" store electrons, the state of motion of the electrons depending upon the temperature. At high temperatures the electrons possess a much greater freedom of motion than at low temperatures. They visualize the states of motion as being "gaseous," "liquid" and "solid." In the "gaseous" state the electrons can occasion the conduction of electricity between the atoms if the latter exist in the same way as they do in metals. In the "liquid" state the electrons are in a state of motion sensitive to light vibrations and therefore they take part in light absorption. In the "solid" state the electrons take part neither in conduction nor in absorption. At low temperatures the spheres of action of the "dynamids" are considered to extend to greater distances than at high temperatures and the free paths of the electrons are therefore greatly reduced.

To each phosphorescent band Lenard and Klatt assign three phases: An upper momentary or heat phase; a permanennt phase possessing quite definite temperature limits; and a lower momentary or cold phase. These phases succeed each other as the temperature falls. The upper momentary phase results when the dynamids do not store electrons. Whenever electrons are stored these return afterwards to the atom from which they were expelled by the light-wave, thus producing the permanent phase of the phosphorescent band. At low temperatures a few electrons return to the atoms from which they were expelled and these cause the lower momentary phase.

The phenomena of phosphorescence are generally conceded to be due to some kind of electrolytic dissociation or ionization of the dissolved substance in the medium about it. Among the first to hold this view were Wiedeman and Schmidt. The theory explains the law of Stokes and many of the other phenomena of phosphorescence.

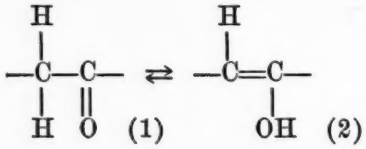
The Light Centers of Organic Compounds

During recent years a very large number of investigations have been carried out concerning the nature of the absorption light centers of organic compounds, both pure and in a state of solution. These centers have been roughly defined as chromophores, the chromophores consisting of radicles of the given compounds that are found necessary and sufficient to produce the given absorption. Among the chromophores that

might be cited are $>C=C<$; $=CO$; $>C=NH$, $-N=O$; $=N=O$; $=C=S$, etc. A bathochrome introduced into an organic compound causes the absorption band to become wider. An auxochrome causes the intensity of the absorption to be greater.

Dynamic Isomerism

Baly and many others have supported the view that the absorption of many organic compounds is due to a change in the valency linking of a compound. This dynamic isomerism is known to take place in many chemical compounds in the presence of a catalytic agent or at high temperatures. Take the case of acetylacetone and ethyl acetoacetate. The absorption in this case may be due to a reaction changing the ketonic (1) into the enolic (2) form and some experimental evidence favors this view.



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Résumé

From the above brief account of our knowledge concerning the nature of the absorption and emission centers of light and heat radiations it will be noted that many advances have been made toward the solution of this problem in recent years. The existence of "electron" atmospheres in many solids, liquids and gases has explained the emission and absorption of spectra that are ordinarily described as continuous; the existence of negative electrons serves to explain many phenomena such as those of the Zeeman effect, etc.; models containing elementary magnets arranged in various ways have been used by Ritz to explain the series classification of spectrum lines; the various phenomena of ionization are being found to be intimately correlated with the phenomena of light emission and much evidence is being accumulated to show that light and heat centers may ultimately be identified as consisting of certain kinds of ions; a very large amount of experimental data has been accumulated concerning absorption spectra of solutions of organic and inorganic compounds and the centers of this absorption seem to consist in certain "aggregates," "chromophores," etc., which can be studied from other points of view; much evidence is found to point to the view that light and heat centers depend upon certain dynamic conditions and are not stable systems such as we usually conceive atoms and molecules to be.

IN QUEST OF THE ALCOHOL MOTIVE

By Professor G. T. W. PATRICK
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ONE of the problems which has been definitely set for psychologists to solve during the twentieth century is the cause of the almost universal desire for alcohol. It is a curious fact that in the thousands and hundreds of thousands of books, articles and writings of every description relating to the many phases of the alcohol problem, this simple and fundamental question—Why do men desire alcohol?—has until recently never been carefully considered at all and even now has not been answered. The belief that the desire for alcohol is due to total depravity or original sin seems to be about as far as we have got in answering this question. One author wrote a serious article not long ago to show that the cause of drinking is to be attributed to bad cooking in the home! He evidently did not appreciate the fact that the desire for alcohol, as well as its use, is at least as old as the lake-dwellers of the neolithic age. Few if any savage tribes known to anthropologists, whether in ancient or in modern times, except certain tribes of Eskimos who have no fruit or grain from which alcohol can be prepared, have been without this drug or some other having similar properties. The discovery and use of alcohol have not spread from tribe to tribe, but have been autochthonic, arising independently in all parts of the world. So keen has been the desire for alcohol and so eager the quest for it, that always and everywhere some means have been discovered by which this water of life could be expressed from fruit, or grain, or vegetable.

And yet we do not even know why it is desired.

The whole vast machinery of the temperance movement, employing thousands of skilled and zealous workers, controlling large sums of money, and making use of wise educational, social and legislative methods, seems to have accomplished little or nothing in reducing the consumption of alcohol. At the very time that legislative and social control of the manufacture, sale and use of alcoholic liquors is extended over larger and larger portions of our country, the relentless figures of the U. S. Commissioner of Internal Revenue show that year by year with almost fateful regularity the per capita consumption of these liquors is increasing instead of decreasing.

The following table shows the per capita consumption of all liquors in the United States from the year 1850 to the year 1911, inclusive:

PER CAPITA CONSUMPTION OF ALL WINES AND LIQUORS

Period	Gallons	Period	Gallons
1850	4.08	1899	16.82
1860	6.43	1900	17.76
1870	7.70	1901	17.65
1871–80	8.79	1902	19.14
1881–90	13.21	1903	19.57
1891	16.72	1904	19.87
1892	17.13	1905	19.85
1893	18.20	1906	21.55
1894	16.98	1907	22.79
1895	16.57	1908	22.22
1896	17.12	1909	21.06
1897	16.50	1910	21.86
1898	17.37	1911	22.79

These figures should not be interpreted as showing the failure of the various means used for the limitation of the sale of intoxicating drinks. There is every reason for believing that these means are in a high degree effective and that without them the increase in the use of alcohol would have been much greater than it has been. The true meaning of the figures is, rather, to show the increasing force of this desire in modern society.

There are, of course, other great human desires besides the desire for alcohol, but in respect to these other desires it seems less difficult to explain the cause. It is not difficult to explain the desire for bread, nor the keen interest in all matters relating to the means of acquiring it. Problems of labor and capital, problems of high prices, problems of production and distribution of food, relate more or less directly to the bread question and become thus wholly intelligible, because bread is necessary to life. Neither is it difficult to understand another profound human desire, which involves serious social problems, the desire of the sexes for each other. Difficult as these social problems may be, the psychologist's part presents here less difficulty, for the place of this great passion in human economy is clear.

The desire for alcohol approaches the above desires as regards both its force and its universality, but its place in human economy is not thus far clear.

The following familiar statistics are not cited in this case to show the extent of "human depravity," nor to point out an "evil" to be suppressed, but rather to indicate the force of a human desire whose cause we seek to determine.

The people of the United States are now consuming annually about 2,000 million gallons of malt liquors, nearly 64 million gallons of wine and more than 138 million gallons of distilled liquors. In Germany the per capita consumption of distilled liquors is about the same as in this country, while their consumption of malt liquors is, per capita, about one third larger than ours and of wine about twice as large.

In England the per capita consumption of malt liquors is still greater than it is in Germany, while the consumption of wine and distilled liquors is somewhat less than in Germany or in the United States.

It is little to the point to call attention to the fact, as has often been done, that the cost of alcoholic drinks to the German people, which is about 3,000 million Marks per year, is nearly three and one quarter times the total cost of their army and navy combined; the cost should rather be compared with other "necessities" of life, such as bread and meat. The force of the desire for alcohol is better shown by noting that its cost to the German people is about the same in amount as their total expenditures for meat, fish and fowl combined, and only one eighth less than their total expenditures for bread, meal, bakery goods and potatoes combined. In this country we have no means of determining accurately the outlay of the people for alcoholic liquors, but we know that the wholesale value of the malt, vinous and distilled liquors produced annually in the United States is approximately six hundred million dollars, almost the same as the total value of our wheat crop. These figures do not take into account the value of wines and liquors imported, nor the output of illicit distilleries. Of these illicit stills, according to the last report of the U. S. Commissioner of Internal Revenue, 2,466 were seized and destroyed during the fiscal year ending June 30, 1912.

An intense human interest clusters around everything connected with alcohol. The very names of the countless forms of beverages, as well as their odors, tastes and colors are all interesting. Language itself reflects the depth of this interest, particularly in the many synonyms for intoxication. Partridge, in his book on "The Psychology of Intemperance," gives a list of about 370 words and phrases in English expressive of intoxication, and he says that a list of more than 600 words in German has been collected. In his opinion nothing except the sexual relation has made a stronger impression upon popular language.

The praise of wine has been celebrated in the poetry of every age. Drinking songs have a peculiar charm. In the history both of religion and of medicine, alcohol has occupied a prominent place and in some form it has been regarded as a cure for every ill. Huge volumes could be filled with the legislative acts of civilized people in their efforts to regulate its sale and use. In recent years an almost incredible number of books and articles has appeared relating to some phase or other of this subject.

It is evident, then that there exists in the human mind, for some reason or other, a profound, persistent and intense desire for alcohol. The psychologist is interested in discovering the cause of this desire and the sociologist well knows that it will not be until this cause has

been determined that any real progress will be made in solving the social problem of alcohol.

How, then, shall the cause of the desire for alcohol be determined? It would seem *a priori* improbable that anything so profoundly and universally desired should not answer to some real need of the human organism. It is clear, therefore, that the first thing to do is to make a scientific study of alcohol and its relation to the body and mind. It is only in recent years that any real attempt has been made to carry out such studies, but they have already cast a flood of light upon the subject. Physiological, psychological and sociological laboratories, hospitals and asylums, medical records and the reports of life insurance companies have all contributed to give us a more accurate knowledge of the action of alcohol on the human body and the human mind and to pave the way for a scientific theory of the alcohol motive. These researches are particularly instructive for the reason that they deal with the real question, *i. e.*, with the effects of alcohol in moderate doses, not with its excessive use. The literature on inebriety, alcoholism and intemperance has always been sufficiently abundant.

It would be impossible in an article of this length to attempt even the briefest summary of these researches. It will be sufficient simply to recall the more important conclusions.

1. The desire for alcoholic drinks is due to the presence of ethyl alcohol, C_2H_6O. Beer, ale, wine, and even whiskey and brandy, have characteristic odors, pleasant to many people and ravishing to some, but it is not on this account that they are desired. The pleasantness of the tastes and odor are largely if not wholly due to association with ethyl alcohol.

2. It is not on account of its food value that alcohol is desired. The researches of Atwater and others have seemed to show rather conclusively that a certain amount of alcohol, say two and one half ounces per day, may under favorable circumstances be oxidized in the body and so act as a substitute for other food by furnishing heat and possibly energy. It is not claimed, however, by those who hold that alcohol may in some cases act as a food that it is on this account that it is desired. The history of drinking, which shows that it has been wholly convivial among primitive people and that it is still largely so, precludes this view. It is only in modern industrial drinking that any attempt has been made to work on alcohol or to live on it, and here the attempt has not been successful, as Sullivan has shown in his careful and painstaking work on "Alcoholism."

3. It has now been pretty definitely shown that alcohol is not a stimulant, and thus there is overthrown at once the most commonly accepted theory as to the cause of the desire for it. Alcohol acts as a depressant upon all forms of life from the simplest micro-organism to the most complex nervous structures in the human brain. It is inter-

esting, however, to call attention to the fact, especially since a few physiologists still claim that under some circumstances it may act as a stimulant to certain bodily organs, that if alcohol were a stimulant, this would not, after all, afford any evidence that it plays a useful part in human economy. A stimulant as such adds nothing to human economy, whether such economy is considered from the standpoint of the race or of the individual. It offers no gain in the long run and could be of no real advantage in the struggle for existence. A stimulant can be serviceable only in emergency cases and under abnormal conditions and as such can not serve as an explanation for a desire extending to nearly all people in all periods of history.

4. The supposition may be made that alcohol increases muscular efficiency, at least temporarily, and that the desire for it may be explained in this way, but the experimental evidence forbids this view. Many series of experiments have been made by Warren, Frey, Schnyder, Destrée, Tavernari, Kraepelin, Féré, Partridge, Rivers and others, using the ergograph and other forms of dynamometer, to determine the effect of small doses of alcohol upon muscular power and efficiency. These experiments have shown that, as the result of small, or so-called normal doses of alcohol, there is a slight initial increase of muscular power followed by a decrease, so that on the whole the results reveal a loss rather than a gain in efficiency. With an increase in the size of the doses, the decrease in efficiency is greater. Later experiments carried out by Rivers and Webber, using a control drink so that the subjects did not know when alcohol had been administered, showed no initial increase of power whatever, Rivers believing that the increase shown in other experiments was due to suggestion. There seems some ground for believing that alcohol, while it does not increase muscular efficiency, shortens reaction-time at first and facilitates the liberation of energy. This may account to some extent for the feeling of increased efficiency which follows the ingestion of alcohol. If it be true that it shortens reaction-time and facilitates the liberation of energy, it still does not appear that this would offer any explanation for the world-wide desire for it. It has not been shown that any decided advantage accrues from the shortening of reaction-time or the quicker liberation of energy. The normal reaction-time and the normal liberation of energy would seem in the long run to be more advantageous. Kraepelin's conclusion is that the laborer who gains his livelihood by the strength of his arm destroys by the use of alcohol the very foundation of his efficiency. The experiments of Hodge, with retrieving dogs showed that the dogs given alcohol did about half as much work as the normal animals. The experiments of Durig in mountain climbing, with and without alcohol, showed that moderate doses of alcohol resulted in a loss of about 20 per cent. in efficiency.

5. Alcohol, again, does not increase mental efficiency. The experi-

ments of Kraepelin and his associates show that moderate doses of alcohol exert a deadening influence on all mental processes. Apprehension is slower, accuracy is lessened, errors are increased, and memory is impaired. The character of associations is also unfavorably affected, the number of higher logical associations being decreased while associations depending upon similarity and contiguity in time and space are increased. Schnidman made experiments on the effect of alcohol in the work of translating from one language to another, with the result that under the influence of small doses of alcohol there was an increase of errors and a decrease of rapidity. The experiments of Lieutenant Boy upon Swedish soldiers in revolver and rifle shooting with and without alcohol showed that accuracy was affected unfavorably by the drug. Mayer found that the speed of writing was lessened by alcohol. In Dr. Aschaffenburg's experiments with typesetters, he found that there was an average impairment of efficiency amounting to about 9 per cent. as the result of small doses of alcohol. Smith experimented on the effect of small doses of alcohol upon memory processes when the drug was administered for successive days. The alcohol in these experiments was administered in the evening and was found to exert a damaging effect upon the memory processes to a very marked degree, the effect increasing from day to day. Fürer found that 80 c.c. of alcohol taken in the evening was followed by increased errors in choice-reactions during the whole of the following day.

Experiments such as the above are difficult to carry out and possible sources of error may enter. It is highly desirable that still further researches should be made in this direction, eliminating every possible source of error. The work to be undertaken in this field by the Carnegie Institution under the direction of Dr. Benedict and Dr. Raymond Dodge will be awaited with great interest. It may safely be said, however, that the experimental evidence is already sufficient to show that it is not on account of any increased mental efficiency due to alcohol that the world-wide desire for it is to be explained. The testimony of Helmholtz in his speech at Berlin on the occasion of his seventieth birthday is significant in this connection. Speaking of the conditions under which he had had his most brilliant intuitions, he said that the smallest amount of alcohol seemed to frighten them away.

The experimental evidence of the damaging effect of alcohol on physical and mental efficiency is confirmed by the practical experience of railroads, steamship companies, shops, manufacturing establishments, contractors, surveying and exploring parties, athletic teams, etc. An increasingly large number of railroads forbid the use of alcoholic liquors to their employees, in some cases even when off duty, while in shops and in mercantile establishments of all kinds statistics show a significant increase of accidents and decrease of efficiency immediately following Sundays and holidays.

If next we consider the contributions of recent science to the use of alcohol in its relation to human health and longevity, we are again met with disappointment in our quest for the explanation of its use. Alcohol was formerly very freely used by physicans in both surgery and medicine, but faith in its therapeutic powers has now been almost wholly lost. The figures given by Horsley showing the decrease in the use of alcohol in English hospitals and asylums during the last twenty years are exceedingly striking. In surgery alcohol has been replaced by antiseptics and in medicine by milk and eggs. Alcohol has now come to be regarded by physicians not as a cure for disease, but as a prolific cause of it. As an excretory product of the yeast plant, its action upon higher organisms is that of a toxin. Its regular moderate use renders the individual less resistant to disease and its excessive use brings a long list of diseases in its train.

The influence of alcohol upon longevity has now been studied with some thoroughness by physicians and actuaries and some definite results have been gained, although here much work needs to be done. The results show at any rate that alcohol does not increase longevity and hence we have here again no clue to the world-wide desire for it. Robert Mackenzie Moore, actuary of the United Kingdom Temperance and General Provident Institute, in a recent report based upon sixty years' experience of that company in the insurance of the lives of abstainers and non-abstainers (the latter being moderate drinkers and good risks and belonging to the same class and following the same occupations as the former), found that in respect to longevity the abstainers showed a marked superiority over the non-abstainers throughout the whole period of life for every class of policies and for both sexes, however tested. For instance, at the age of 30 the expectation of life for the non-abstainers is 35.1 years; for the abstainers, 38.8 years, a difference of nearly 11 per cent. At the age of 40, the percentage of difference is the same. Another very thorough and impartial investigation has been made by Mr. Edward B. Phelps on the mortality due to alcohol. It is based on the testimony of the medical directors of three prominent life-insurance companies of America. Mr. Phelps's conclusion is that 8 per cent. of all deaths of adults in the United States are due to alcohol.

If we turn finally to the social relations of men in our search for an explanation for the universal desire for alcohol, our reward is even less. Alcohol indeed encourages sociability, but it would be hard to show that this in itself is a benefit proportional to the desire for it, and we find in connection with its use a long list of social evils, such as poverty, crime and racial degeneracy. These evils are connected for the most part with the excessive use of alcohol and consequently they interest us only indirectly here; but it would appear to be one more disadvantage to be attributed to alcohol that its moderate use is apt to

issue in excessive use and so lead to many unhappy and disagreeable consequences, such as drunkenness, disability for work, domestic trouble, poverty, crime and degeneracy of offspring.

We are thus brought finally face to face with the question, Why do men desire alcohol? The theories hitherto advanced in explanation of the alcohol motive have failed to take into account certain essential facts in regard to the problem and have therefore been incomplete. Among these facts are the following: The desire for alcohol is common both to civilized and uncivilized man. It tends to increase rather than to decrease with the advance of civilization in spite of vigorous and to some extent successful efforts to restrain it. It has reached an unparalleled degree of intensity at the present time in prosperous communities relatively rich in comforts and luxuries. It is strong, again, in industrial and manufacturing centers among plodding and underpaid laborers. It is somewhat stronger in northern progressive races than among the less progressive southern people. It is particularly characteristic of the adult male individual, the desire being decidedly less strong in women and children. It is not an appetite in the ordinary sense of the word, as it answers to no inner need of the body so far as is known. To these facts should be added those specially noted above, namely, that alcohol apparently adds nothing to either physical or mental efficiency, that it contributes nothing to health or longevity, and does not enhance social well-being.

Is it possible to explain the desire for alcohol on the ground of its immediate pleasurable mental effects? It deadens pain to some extent and drives away care. It produces a feeling of euphoria, of well-being, comfort, contentment, ease and inner harmony. Under the influence of alcohol many of the unpleasant feelings accompanying the daily drudgery of life temporarily disappear or are at least alleviated, such, for instance, as fatigue, apprehension, fear, worry, anxiety and to some extent physical pain. Selecting one from any number of illustrations which might be drawn from literature, we read in Gösta Berling:

> The year had dragged itself out in heavy gloom. Peasant and master had passed their days with thoughts on the soil, but at even their spirits cast off their yoke, freed by brandy. Inspiration came, the heart grew warm, life became glowing, the song rang out, roses shed their perfume. The public house bar-room seemed to him a tropical garden, grapes and olives hung down over his head, marble statues shone among dark leaves, songsters and poets wandered under the palms and plane trees.

Another author, picturing the hopeless grinding toil of the coal miner, his monotonous and unillumined life, his long work day, his hasty and insufficient supper and his hard bed, says that at the end of the week when a little respite comes, the "demand for joy" drives this coal miner to the saloon.

But this explanation, at first sight partially adequate, when more

carefully considered, encounters serious difficulties and only adds to the obscurity of the subject. Are we to understand that the desire for alcohol is due to the "demand for joy"? There never was a time in the history of the world when, quite apart from alcohol, joys were so abundant as they are in America at the present day. The rich have every comfort and luxury and the poor have every humane consideration, while laborers have shorter hours, better pay, better food and better clothes and more books, papers and other forms of entertainment than ever before in the world's history. We are comparatively prosperous, happy and well fed, have abundant leisure and countless comforts, yet it appears that we need 2,000 million gallons of alcoholic liquors yearly to complete our "joy." Furthermore, if this were the correct theory, it would be impossible to explain the lesser desire for alcohol among women, for although at present in America the lot of woman is a relatively happy one, this has not been the case among primitive people, nor in historic times, nor even in other countries at the present time. Her life has been relatively monotonous and laborious and her joys and amusements have been fewer.

But serious psychological objections to this theory appear also. Joy and pleasure are the mental accompaniments of physical well-being, of mental and physical health, while alcohol acts as a poison in the presence of all forms of life. Against this apparent contradiction little is gained by saying that the joy of alcohol is an abnormal joy answering to an abnormal or diseased condition. The desire is too universal, too fundamental, so to speak, for that. Or if we say that alcohol brings an immediate and temporary joy, while its poisonous effects are delayed, we encounter two difficulties, first the difficulty of showing what particular kind of benefit corresponds to the immediate and temporary joy, and second the difficulty of explaining on any principles of evolution the desire for a drug whose effects are on the whole injurious—a desire which is so strong and so universal as almost to merit the name of an instinct. This seems to be a kind of deadlock to any further progress in arriving at a theory of alcohol. But the joys of alcohol are evident and its injurious effects are equally evident. It is clear, therefore, that the "demand for joy" theory is only a superficial statement of a certain truth whose explanation lies deeper.

But leaving for the moment the "demand for joy" theory, let us consider the view that alcohol banishes care and drives away sorrow and pain, in other words, that it is narcotic in its action, a kind of sedative or anesthetic. This theory seems at first sight to account for some of the facts. It is now generally, though not quite universally, admitted by physiologists that alcohol is not a stimulant but a narcotic. It apparently paralyzes the higher brain centers and in thus inhibiting the inhibitory centers produces effects resembling stimulation. Fur-

thermore, pain, sorrow and care are ever present in human life, making the universality of the desire thus far intelligible.

But clearly the narcotic theory encounters difficulties from the same sources as the "demand for joy" theory. It fails first to account for the lesser desire among women, who have certainly at all times had their share of sorrow, pain and care. It fails likewise to account for the increase of the desire in times of prosperity and activity, or in times like the present of improved hygiene, increased longevity and multiplied pleasures and comforts. Finally, the narcotic theory, if it were true, would seem to be nature's checkmate upon itself, for pain in all its forms is evidently purposive. Are we to suppose that nature has discovered a way to tear down its own danger signals? The narcotic theory would be available only in respect to times of degeneration and national decay. Nordau, who explains the desire for alcohol in this way, regards the present as such a time of degeneration, and Partridge, who recognizes the narcotic motive as one of the elements in the desire, seems to think that so far as it is present it betokens "old age and disease in a nation." But since the desire flourishes most strongly, as we have seen, in times of great national vigor, such for instance as prevail at the present time in Germany, England and America, the narcotic theory seems to fail. Nevertheless, it may appear below that the narcotic motive is present, after all, only not in the form hitherto recognized.

Another writer, Reid, has broached the theory that the desire for alcohol is a by-product of evolution, a specific craving which nothing but alcohol will satisfy. It is coextensive with the human race and harmful in its results, and is to be met in only one way, namely, by the automatic action of "evolution against alcohol," by the action of natural selection in gradually eliminating those not immune to the desire. It is part of Reid's theory to maintain that the people of southern Europe have become partly immune to alcohol, owing to its abundant supply, and are therefore more temperate. Almost all the facts upon which this theory is based are open to doubt.

Partridge, while recognizing the narcotic motive in the desire for alcohol, "the longing to escape from pain, to seek relief in inactivity and rest, a turning backward from the strenuous life," apparently believes that the so-called "intoxication motive" is more important. It springs from the desire for states of consciousness of higher intensity, for feelings of exaltation, for life and life more abundant, for freedom and expansion, for states of higher tension. It is the erethic impulse, a craving for excitement. But the evidence is overwhelming, as we have seen, that alcohol, so far from contributing to the more abundant life, contributes from every point of view to the less abundant life, and as for the desire for states of higher tension, there is every reason to believe, as will be shown in what follows, that alcohol produces states of lower tension and is desired for precisely this reason.

And if the desire for alcohol were due to a longing for excitement, life, tension, movement, this longing would seem to be well satisfied by the conditions in modern American cities without recourse to 2,000 million gallons of alcoholic liquors yearly.

Any satisfactory theory of the alcohol impulse must not only take account of the facts to be explained, some of which we have mentioned above, but it must also be grounded on an accurate knowledge of the whole life history of man, particularly his mental development and the corresponding development of the brain. It would be necessary, furthermore, for such a theory that we should have an accurate knowledge of the action of alcohol on the human brain. Neither psychology nor physiology is able as yet to furnish this knowledge completely, so that any theory of the alcohol motive must be tentative, awaiting further scientific advance. The following observations, therefore, although for brevity's sake put in somewhat dogmatic form, may be considered as suggestions toward such a theory.

Human progress seems to be in a certain definite direction and to involve the development of certain definite mental powers and of the corresponding higher cerebral centers. The chief of these powers is that of voluntary, sustained attention, which differentiates man sharply from the lower animals and likewise distinguishes civilized man from the savage. Progress has been possible because man has been able to narrow the field of attention, to concentrate or focus his powers, to live under mental stress, strain and effort and to hold his attention on a definite object. The word "tension" may perhaps express both psychologically and physiologically the subjective correlate of progress. It is characteristic of the savage as compared with the lower animals, of civilized man as compared with the savage, of northern races as compared with southern, and of the male as compared with the female. As concentration, sustained attention and abstraction, it issues among civilized man in science and invention. Whether the product be Newton's Principia or Edison's talking machine, or even the long-sustained working-day of the common laborer, it presupposes the above-mentioned powers and involves the constant enlargement of the higher cortical centers of the brain. There is something, whether it be the "will to live," or a "vital impulse," or the cosmic consciousness, or only natural selection, that is eternally driving us on in this direction.

Now the higher and newer the brain centers, the more subject they are to fatigue and the greater is their need of rest. During sleep these centers enjoy almost perfect rest, our dream activity taking the form of passive revery. But eight hours of sleep are not sufficient for this part of the brain. Sixteen hours of sustained attention would probably result in immediate insanity, if such an act were possible. Nature seems to demand some form of activity which shall allow the higher brain centers to rest while providing employment for the lower ones. To such a condition of mind and body we apply the name *relaxation*

and it embraces a considerable portion of our daily activity. It is most perfectly typified in play and sport, but includes many other forms of human interest and activity, such, for instance, as the enjoyment of music, of the drama and of other forms of fine art, the reading of fiction, and countless other kinds of amusement and entertainment not commonly included under the terms play or sport.

But it is in children's play and in adult sport that we find the principles of relaxation best exhibited as they will be found presently to bear upon our problem. The active life of the child is almost wholly a life of play. The brain centers developed late in the history of the race come to maturity late in the life of the child. Hence he rebels instinctively against work, for it involves yet undeveloped centers, those connected with spontaneous and sustained attention. Play is self-developing and supplies its own interest. Furthermore, a study of children's plays shows that they are largely reversionary in form, following the old racial activities of our remote ancestors. The boy, therefore, runs, races, rolls, wrestles, wades, swims, climbs trees, shoots with sling or with bow and arrow, goes hunting, fishing, canoeing, camping, builds tree houses, cave houses, wigwams and pursues a hundred occupations recalling the life of primitive man and far removed from the serious life of modern man, the life of the farm, the shop, the office, the factory, the bank or the schoolroom. The brain paths involved in children's play are the old time-worn easy paths requiring no new associations, no abstractions, no strong and sustained effort of will or attention.

In adult sport we have a still better illustration of the principles of relaxation. If we recall those forms of sport which afford the most perfect rest and relaxation, we shall see how true it is that they are of a character to use the old racial brain paths and rest the higher and newer centers. The tired teacher, lawyer, doctor, preacher or business man, when his vacation comes, reverts to the habits of primitive man. He takes his tent, rod, gun or canoe and goes to forest, lake or mountain, wears more primitive clothes, sleeps on the ground and cooks over a camp fire. Hunting, swimming, yachting, dancing, wrestling, prize-fighting, horse racing—all these are illustrations of the rest afforded by primitive activities. As forms of relaxation they seem so natural to us that often we do not realize how primitive they are and how far removed from the real work-a-day world of modern life, the world of mental concentration, of pen and ink and books, of clerks and stenographers, of office and court room, of flats and congested cities, of business and finance. A football game, which resembles the rough and tumble physical contests of former days, brings together fifty thousand wildly enthusiastic spectators, while an intercollegiate debate commands at most only a handful of hearers with mild enthusiasm, so great is the need of some form of relaxation that shall completely relieve the tension of modern life. The gladiatorial exhibitions of old

Rome attracted enormous crowds of eager spectators because of the primitive character of the spectacles. The direct physical contact of man with man or man with beast intoxicated the Romans, whose work-a-day world was not unlike our own and far removed from the life of the arena. Such spectacles awoke the echoes of the past, revived primitive instincts and afforded perfect rest and relaxation. The behavior of the spectators at a football game is an illustration of perfect relaxation. They act for a time like children or savages and return to their work rested and purified.[1] Mankind appears to be under the dominance of two opposing forces. On the one hand we are driven on by the relentless whip of progress, which demands ever greater and greater specialization, application, concentration and powers of conceptual analysis. On the other hand the tired brain rebels against this ceaseless urging and seeks rest and relaxation.

But, now, even in the early history of the race, there was discovered another means of relaxation, artificial to be sure, but quick, easy and convenient. Drugs of various kinds, owing to their peculiar action upon the brain, produce a kind of artificial relaxation. Ethyl alcohol, produced everywhere whenever the ever-present yeast cells come in contact with the sugar of crushed fruit or fermented grain, has the peculiar property of paralyzing to a greater or less extent the higher and later developed brain tracts which are associated with those peculiar forms of mental activity accompanying work and the strenuous life. The later developed and more delicate centers of the nervous system are more susceptible to the attacks of an intruding destructive agency, such as alcohol. Thus it comes about that alcohol answers the demand of the body and mind for relaxation and accomplishes in an artificial way what is effected in a natural way by sport and play and other forms of relaxation. The latter effect this end by turning the energy of the brain into lower and older channels, leaving the higher centers to rest; the former, by directly narcotizing the higher centers and thus liberating the older, freer life of the emotions and the more primitive impulses.

It should not be understood that alcohol has any "selective affinity" for any part of the nervous system. Its action, like that of other toxins, is no doubt diffusive, but affects most seriously those parts of the brain having less power of resistance, particularly the centers late in the order of development. Its depressive effect is felt to some extent, however, upon the lower reflex centers and as such results again in physiological relaxation. This is owing to the fact that its depressive action raises the threshold value of the reflex arc and so diminishes reflex excitability.

From this point of view, therefore, we see that while the action of

[1] For a fuller account of the anthropological theory of sport and play, see the article by the present writer on "The Psychology of Foot-ball," in the *American Journal of Psychology*, Vol. XIV., pp. 104–117.

alcohol is narcotic, nevertheless the narcotic theory, as it has hitherto been presented, is very one-sided, and the truth in the narcotic theory as well as in the stimulation or intoxication theory is now brought into proper relief. One would not say that play and sport are narcotics. They seem to be very refreshing and stimulating. In the same way alcohol is stimulating, not directly, for its physiological action is wholly depressive, but indirectly by inhibiting the higher brain centers and setting free the older and more primitive psychoses. Thus it appears as a depressant of voluntary attention and effort, of logical associations and abstract reasoning, of foresight and prudence, of anxiety and worry, of modesty and reserve and the higher sentiments in general, while, on the other hand, it acts indirectly as an excitant of speech, laughter and song, of emotional feeling and expression, of sentimentality, and in increased doses, of still older and more basic impulses, such as garrulity, quarrelsomeness, recklessness, immodesty and, finally, of coarseness and criminal tendencies. Thus under the progressive influence of alcohol we see the whole life history of the race traversed in reverse direction, for the criminal life of to-day represents the normal life of primitive man.

We thus trace the desire for alcohol to the inherent need of mind and body for relaxation, a need normally supplied by all the varied forms of play and sport. Physiologically it is expressed by the need of rest felt by the higher brain centers upon which conditions of civilization bring so severe a strain. Psychologically it is the expression of the desire for release from the tension of the strenuous life. In a sense, therefore, it is the strenuous life which is responsible for the alcohol impulse, but it should be noted that the word "strenuous" is here used in a broad sense. It does not refer necessarily to an exciting, active, high-pressure life, but refers rather to any condition of unrelieved tension, where sustained effort is demanded with little opportunity for complete rest and relaxation. While these conditions are perhaps best encouraged by the high-pressure life of our cities, they are also present in the unrelieved toil of the industrial worker.

We are in this way able to understand some of the facts which, as we have shown, must be considered in any theory of the alcohol motive. We may understand not only the increased desire for alcohol in modern life, but also the lesser need for it on the part of woman. Woman is less modified than man and presents less variation. Her life is calmer and more even. She is more conservative, representing the child type, which is the race type. Her life is less strenuous. She is not keyed up to so high a pitch and hence has less need of relaxation and feels less demand for play and sport. Man, on the other hand, represents variation. The mental powers peculiar to advancing civilization are more developed in him. He has to be in the vanguard of progress. With him, therefore, the stress of life, the tension, the ex-

citement, are greater and he feels more the need of the harmonizing action of alcohol.

Again, we can understand why even the primitive man finds alcohol a relief, for the tension of his life is great as compared with the lower animals and we can understand why the desire increases with the progress of civilization and the corresponding increase of tension. The stress of life is greatest among the Anglo-Saxon people and greatest of all perhaps in American cities at the present time. In this country especially, the intense life of concentration, of effort, of endeavor, of struggle, of rapid development, has for its correlate an intense longing, not for stimulants,—for our life, our climate, our environment are surely stimulating enough,—but for rest, for relaxation, for harmony, for something to still temporarily the eternal turmoil.

Does the fact that the desire for alcohol is increased by the indulgence in it and the apparent fact that those who fall victims to its excessive use are not always those most in need of its harmonizing action present any difficulty in this theory? Probably not. The desire for relaxation is not necessarily increased by the use of alcohol but only the ever renewed demand for that which produces the longed for effect, and, again, it is not certain that those who fall victims to its excessive use are not those most in need of its harmonizing action. Here the element of prudence and self-control must be taken into account. Excessive users may be those having lesser control or greater opportunity, not those experiencing stronger desire. While the desire for alcohol is increasing with the complexity of society, it is actually true that drunkenness is decreasing and it is possibly true that the number of total abstainers is increasing. These things are determined by custom, by individual environment and education and by the power of self control. But the steady increase in the desire for alcohol is shown not merely in the steady increase in its consumption but still more in the fact that it increases in the face of public and private sentiment, legal statute and social effort.

We see also why the use of alcohol has commonly followed the law of rhythm. Among primitive tribes drinking was periodic, wild orgies of intoxication following considerable periods of the plodding life. This periodicity is seen in convivial drinking of all times and is a familiar fact in every community at the present. The power of self-restraint, strengthened by public sentiment and private prudence, deters from the use of alcohol up to a certain point, when the cumulative force of the desire, which is the cumulative need of release from painful tension, overthrows all barriers and excess and complete relaxation follow for a season.

So it appears that the effect of alcohol is a kind of "catharsis." We recall Aristotle's theory of the drama, which, he says, purifies the mind by giving free expression to certain of the emotions. In a way, therefore, the significance of alcohol is that it is an escape. It is not

in itself desired; often enough it is hated. But the user finds himself under the rule of an imperative, an insistent idea, a tormenting presence, and this presence is his whole deep human personality crying out against the eternal urge of the "will to live." The spirit of the age proclaims that we must be efficient. Efficiency, and ever more efficiency, is demanded and the desire for alcohol is the desire for rest, for release from the tension, for freedom and abandonment. Nietzsche, crying out against this spirit of progress, says:

> Why does precisely this gloomy and vehement oppressor pursue me? I long for rest but it will not let me.

The relation between the effect of alcohol and that of the drama is again clearly expressed by Benjamin Ide Wheeler, when he says:

> That which was at the beginning the charm of the drama, and has been, so far as it is true to itself, ever since, is its power to release those who behold it for a little while from the burden and enthrallment of the commonplace workaday life, and bathe their wearied souls in dreams. This is the very heart of Dionysus, and this too is his claim to control the fruit of the vine.

But now, if this theory is correct, what is the conclusion? Is alcohol a means of purification through relaxation? Just so far as it affords rest to the wearied higher brain centers and relief from the tyranny of the will, it is a means of purification, but unfortunately it is at the same time a poison, bringing in its train a heavy residuum of damage not only to society, but to the individual. The imperative need of relaxation is apparent, but, while play and sport are relaxing and recreative, alcohol is relaxing and destructive. The colossal evil of its excessive use is evident to every one, but there is reason to believe that even its moderate use detracts from the sum-total of well-being of the individual in exact proportion to the amount used. It is possible, however, that the case is still worse. Let us suppose that alcohol were not a poison, that it had no effect beyond a slight paralysis of the higher brain centers. What will be the cumulative effects of such action upon the individual and the race? This question can not at present be answered. It seems probable that this constant doping of the highest and most delicate nervous centers, while it affords the needed relaxation, may work havoc with the delicate organization of the brain. Possibly alcohol represents a factor of maladaptation in the evolution of man and will prevent the realization of his highest destiny. If we consider the degree of civilization attained by the ancient Greeks, several stages above our own in art, and on an equal plane at least in poetry, in eloquence, and in philosophy, we are impressed with the slight progress we have made, when measured by a reasonable expectation based on the time which has elapsed and our rich intellectual inheritance. Gladstone bemoaned the lack of progress in intellectual power made by man in recent centuries. Is any one in position to say that this has not, in part at least, come about from meddling with ethyl alcohol?

THE NEXT COLLEGE PRESIDENT

By A NEAR-PROFESSOR

IT was in the autumn of 1911 that the press gave wide publicity to a meeting of college presidents, deans and professors convened in honor of the installation of the chancellor of a metropolitan university. At the dinner that closed the ceremonies one of the speakers, himself the president of another great university, assured the audience that being a university president was great fun since among other perquisites of the position was that of being able to dine on college professors.

The press reports of the dinner were read by a near-professor as he sat in his modest study in a distant college town. The phrase used by the distinguished university president seemed strangely familiar, and turning to a package of notes in his desk he found among them the record of a conversation with a former colleague and read in the words of his friend, "Sometimes the board of trustees eats the president, sometimes the president eats the board of trustees, but both always eat the faculty."

It was indeed passing strange, the near-professor pondered, to find such unanimity of opinion between a great university president and a humble college professor as to the part in the educational system played by the college faculty, and henceforth he felt his own course was clear; if the high cost of living restricted his own daily menu, he could at least serve the cause of education by cheerfully recognizing his place and becoming the baked meats for the table of his academic superior.

But before consciously laying his head on the president's dinner platter, it seemed wise to the near-professor to turn again to his bulky package of notes. They were the accumulations of several years and they represented the reports of presidents of colleges in nearly every state in the union, anonymous articles by college professors that had appeared in all of the leading reviews of the country, anonymous letters on educational organization written to the press and turned over to him by a journalist brother, memoranda of conversation that he had had with professors from other colleges when they were separated by the Atlantic from their academic dinner tables, descriptions of the organization of education in nearly every country in Europe, private letters from personal friends whose official heads had yielded a Barmecide feast to various college presidents, and fragments from his own observation and experience.

As he examined the mass of material he was conscious of a secret

fear lest its very presence in his desk should betray him into the hands of his official superiors. He could indeed justify its presence there on the ground that the accumulation was in large part accidental, that "he had not meant to do it," that the small field of knowledge in which he had been permitted to work had been so intimately connected with all questions of organization that he could not well avoid an interest in the by-product of educational organization—still and all, he had to admit that he was a victim of abject, craven fear. Yet in his early youth he had fortified himself against the oncoming of age by committing to memory Longfellow's "Morituri Salutamus," and now its appeal to banish fear, doubt and indecision stood him in good stead, not so much against old age, for that seemed farther away than it had at twenty, as against the spectre of a frowning chief and a possible official decapitation. The material in his desk, he reasoned, might be of some slight service in the discussion of a question that was filling every year a larger and ever increasingly larger place in the minds of all engaged in educational work, whether as college professors or as teachers in the public schools. He was as much in honor bound, he reasoned again, to make his contribution to the cause of education as he was to pay his pew rent in church and to give of his wife's substance to the foreign missionary cause.

Turning his attention first to the organization of the so-called "higher institutions of learning," the near-professor found that the factors directly and indirectly concerned are eight.

The factor least immediately involved is the public at large and it may be called collectively the state. It has no direct part in the government of higher educational institutions except in those states where members of the boards of regents are elected by popular vote. The state has, however, a direct financial interest in the subject since the property of educational institutions on private foundations is exempt from taxation, and on the other hand public educational institutions are supported by state taxation.

The parents of students have as such no part either direct or indirect in the management of a college, nor do they consciously to themselves exert the most remote influence on the conduct of its affairs. Nevertheless, the parent is a potent factor in shaping the policy of a college, through serving as a foil against proposed innovations. Do the students desire a larger measure of self government, the parent "who would not approve" prevents its realization. Do the alumni favor a radical departure from the curriculum that has been in force, the parent "likes what we have and sends his son here to get it," and hence no change is made. Does some one suggest dropping the Latin salutatory and the valedictory from the commencement exercises, the parent "likes the present plan" and therefore the Latin salutatory and the valedictory are retained. If

the college authorities believe that they stand *in loco parentis,* they are certainly right in governing their action by the supposed wishes of parents. Yet it is not known that a poll of the parents has ever been taken on any subject of college policy, it is quite possible that the expressions of approval or disapproval of proposed changes are purely individual, it is even probable that the opinions expressed are such as are felt to be in harmony with the wishes of the administration, and it is altogether credible that the shade of the absent parent has been evoked to give countenance to policies of the administration as unalterable as were the laws of the Medes and Persians.

The benefactor has long been recognized as a powerful, although unacknowledged, influence in the administration of the college on a private foundation. He is a member of the board of trustees and as such wields great authority. He is consulted on all matters of college policy, his wishes are deferred to whenever a difference of opinion arises between him and his colleagues, and he is the power behind the throne on which sits the college president. To him more than to any other giver is applied the adage that one must not look a gift horse in the mouth. If the benefactor is interested in science and wishes to give the college a physical laboratory, the college accepts it without question although its greatest need may be for a new library building. If the benefactor thinks "the boys" need more athletics, he spends a fortune on a stadium even though the college may be in crying need of funds to pay the salaries of its professors. If the benefactor thinks a building would adorn a sightly part of the campus, he puts one there, even though the college may not have sufficient funds to keep it adequately cleaned, warmed and lighted. "I would a thousand times rather have dealings with a state legislature than with the private benefactor on whose will or whims the welfare of a university depends," said a president who had had experience as the head of a state university and of one controlled by "the munificent benefactor." It is possible to meet political influence fairly, squarely and openly, but it is impossible to meet the undue personal influence of the private benefactor who may be giving to the college his time and his energies, as well as his funds, but is practically irresponsible. The zeal of the benefactor is appreciated, yet it often is an illustration of misdirected energy since the educational interest realized on the capitalistic benefaction is sometimes in inverse proportion to the amount invested.

The student body is as yet a somewhat inert mass as regards its attitude toward educational policies. The force of tradition is strong and tradition makes the student, at least in theory, passive and receptive rather than active and creative; it teaches him unquestioning obedience to authority; it scoffs at his desire to know the meaning of what he does; it mocks his wish to have a part in deciding the policy that controls his

daily actions. Even the community in which he lives is prone to scorn his efforts to play a part in the settlement of the questions that intimately concern him.

A few years ago internal troubles in one of our universities led to a rumor that the president had asked for the resignation of every member of the faculty. In consequence of this a mass meeting of the students was called, but before the students assembled a message was sent them by the president saying that no meeting would be permitted unless the students agreed to act in accordance with his wishes.

A few days later one of the city papers in discussing the situation said editorially,

> First of all a warning should be given to the students. They should be politely, but firmly, ordered off the stage. They are not in the remotest degree a factor in the present affair. The factors are the president, the directors and the taxpayers as a body. The students, who contribute next to nothing to the finances of the university, represent only 400 or 500 taxpayers. The student body of the university represents an insignificant fraction of one of the three factors of the present issue, and, therefore, should have so small a voice in the affair that it is not worth considering. And they should remember that what voice they have is as taxpayers, not as students.

Nevertheless, tradition does not always remain impregnable and there are signs of weakness in some of its strongholds. The college student may have come from a school city where in a public high school he has had some small share in educational legislation and administration. He may have entered from a private secondary school where self-government has attained a vigorous growth. If in college his abilities lead him into the field of science, the spirit of investigation he meets there turns his questioning mind to the investigation of education; if his interests lie in political science the organization of the state directs his thoughts to the organization of education; if he is absorbed in economics, the question of the mutual relations of capital and labor, of employer and employee, of the individual and the state lead to questions of the mutual relationship of all parties concerned in education; the very process of education trains him in mental activity and he is quick to apply this activity to the study of the conditions in which he is placed.

Again, he can not escape the discussion of all phases of the question as it is presented in the daily press and in current periodicals. The spirit of research, of investigation and of inquiry in every form is abroad in every land, and it has its influence on the college student. Democracy in the state, in society, in industry, is taking on new meanings and is making new applications. Experiments in self-government are being tried in reformatory, corrective and penal institutions, and even hospitals for the feeble-minded and for the insane are turning to the same plan as part of their remedial treatment.

Even the college student himself has often had personal experience in matters of government. The average age of the college man at graduation is about twenty-three and he has been a possible voter for two years. If he has sufficient maturity to have a voice in the decisions of affairs of state, is it not reasonable to suppose, he asks, that he can be given some small share in the decision of educational matters that immediately affect him?

That the college undergraduate has had as yet so small a share in the conduct and policy of the institution with which he is temporarily connected by no means augurs that his share will continue permanently negligible.

The alumni of a college have but recently been given a representation on boards of trustees. This representation has not always been warmly welcomed by the boards as previously organized, and it has been granted only through the persistent efforts of alumni organizations. These efforts have been made because of a growing feeling that some official medium of communication is necessary between a board of trustees and the undergraduate body. The college has, moreover, been enlarging its activities along lines not strictly academic, and with the increasing interest in college athletics, college dramatics and college musical clubs, appeals have been made to the alumni to assist in financing these enterprises. These appeals have usually been made through class organizations, alumni associations, and the graduate and undergraduate college press, and the very appeals themselves have stimulated interest in general college affairs. One result has therefore apparently been to increase the general contributions of the alumni to their alma mater and this fact has furnished another and perhaps more valid reason for the election of a limited number of trustees by and from the alumni themselves.

Just how effective this representation is in influencing the policy of boards of control is at least a question. The alumni trustees are always in a minority, they hold office for a limited term while their colleagues on the board usually are elected for life, their point of view may not always be that of the other members of the board, yet they are often cautious, if not in reality timid, in expressing views divergent from those of the majority, they represent a body having no legal but only a sentimental relationship to the institution, and they are as a rule only contributors of ideas not signers of checks. But if the direct results of alumni representation seem somewhat negligible, the indirect results of such representation have been most wholesome. It has stimulated the loyalty and the enthusiasm of college graduates in behalf of their own college, it has led to acquaintance among the alumni representatives of different colleges and thus to the exchange of facts, opinions and experiences to the profit of all concerned, it has resulted in a more intelligent

appreciation of what the great educational problems of the day really are, and it has aroused a desire to have these problems investigated by experts in order that the layman may have put before him authoritative data as a basis for discussion. If we have everywhere to-day a passion for education that partakes of the religious fervor of an earlier time it may in large part be explained by this thin entering wedge of alumni representation on boards of college trustees.

The part taken by the state, the parent, the benefactor, the undergraduate body and the alumni is either too slight to have an appreciable effect in formulating educational policy, or it is too irresponsible to be met and discussed in the open, or it is prophetic of future opportunities rather than a chronicle of past achievement.

In the eye of the law the only authority responsible for the conduct of the affairs of a college is that vested in the board of control, usually denominated a board of regents or a board of trustees. The nature and the measure of this responsibility is largely determined by the source of the financial support of the institutions concerned.

Higher institutions of learning are of two general types as regards this support. In universities supported by the state, the members of the board of regents may be appointed by the governor of the state or elected by the qualified voters of the state; in either of these cases, the members of the board hold office for a limited term of years. Colleges on a private foundation are controlled by a board of trustees whose members form a close corporation. They are self-perpetuating and are elected for life, although a recent modification of this plan provides that members of the board are to hold office for a limited term and membership may be automatically changed at the end of a definite period. But irrespective of number of members, term of office, and method of appointment or election, the result is the anomalous one of placing in control of nearly every great and every small institution of higher learning in America a body of men that have no connection with the educational work of the institution, that are not members of its faculties, that are not necessarily numbered among its graduates or its former students, or indeed among those of any other college or university. Yet the control of these external bodies over our educational institutions is absolute in that both the financial and the educational policy come within their jurisdiction, and their control is irresponsible in that they render no account of their stewardship and as a rule they hold office for life, not during good behavior. Technically and legally all-powerful, these external boards of control do not exercise their authority directly, but they delegate it to their appointee, the college president. He thus in his turn becomes all-powerful, not by virtue of original and vested authority but through authority delegated to him by these boards.

It is thus seen that the most important function of this external

board of control is to-day that of appointing the college president, and that the great power in the educational world thereby becomes the college or university president.

The position of the American college president is absolutely unique in the educational world, yet the evolution of the office has been a simple one and it is easily traced. The great majority of the older colleges in America were founded either by ecclesiastical organizations or, in communities where the civil and the ecclesiastical power, were identical, by the state, and the function of its college was to educate young men for the ministry. Thus it followed that at first the college president sustained much the same relation to the student body that the pastor of a church sustained to the members of his congregation—he was the spiritual teacher and adviser, the religious head of an institution founded for religious purposes. The first and the final test of his qualification for the position was that of orthodoxy, and when this was called in question his position as president of a college was no longer tenable. But as the ecclesiastical rigor that bound both church and state gradually relaxed, a change took place in the qualifications demanded of a college president. Education as a process came to be more emphasized and it became necessary for the college president to be not only a clergyman, but also to have a strong and commanding personality. The college president became the great teacher—a class of which Mark Hopkins will always stand as the type—and his chief financial duty was to raise funds for scholarships for the education of "worthy young men."

The next step in the evolution of the college president came when the college was frequented by young men whose career in life was to be, not the ministry, but one of the other learned professions, or business, or some branch of applied science. This necessitated the development of the secular side of education, and with this development came the demand for increased appliances, for laboratories, for large additions to libraries and museums, for the enlargement in every direction of the educational plant. Funds must be raised to provide this equipment and on the shoulders of the college president was laid the burden of securing them. Thus the college president became not only the religious head and the educational head of the institution, but its financial agent.

But it followed naturally that if large endowments were to be secured by the college president, he must be "a good mixer" with those who might be persuaded to contribute to the college. A clergyman, a scholar, a recluse, might possibly teach, but other qualifications for raising funds were imperative. He must be a man of fine presence, genial manner, consummate tact, a ready and acceptable public speaker —he must be in the best sense of the work, "a man of the world." The college president thus added to his previous qualifications of clergyman,

teacher, and financial agent that of a fitting social representative of the institution.

But increased and increasing endowments entailed the burden of organizing and administering them. The funds secured must be wisely used and no one could hope to be successful as the head of an educational institution who did not unite with the ability to raise funds that of a wise administrator.

But wise administration is a complex term. It implies the organization not only of the internal but of the external affairs of an institution—the care of buildings and of grounds, and even familiarity with a species of hotel-keeping if the college has dormitories or residence halls.

Thus by an accumulation of duties that have been added as the scope of the college has broadened, the college president has added to his primary qualification of religious head that of educational head, financial head, social head and administrative head, including the duties of superintendent of buildings and grounds and even those of hotel proprietor. It has been a veritable piling of Ossa on Pelion and the office has become so burdened with duties and responsibilities that it seems as if it must break down of its own weight.

A person unfamiliar with the situation might reasonably conclude that all of our colleges and universities were threatened with bankruptcy and had been placed in the hands of a receiver so unlimited are the powers that have been conferred on their presidents. But those whose acquaintance with present conditions makes it possible for them to understand the steps by which this present development has been reached know that the powers now placed in the hands of the president have been cumulative and in a measure accidental rather than the result of fixed plan.

Of the eight factors concerned in college legislation and administration, seven have been considered. It remains only to examine the part taken by the faculty in the government of the colleges with which they are associated. Singularly enough this part seems entirely negligible. The faculty of a college has no voice in the election of a president who is to rule over them by appointive if not by divine right, nor are its members, as far as known, ever consulted when a choice of president is to be made, nor are even expressions of opinion sought from them.

It is also true that no college professor is ever a member of the board of trustees that governs the institution with which he is connected, and that he is even in some cases expressly prohibited from ever becoming a member of the governing body. The corporate state may be represented by its governor who may be *ex officio* a member of the board of trustees of a college within the state; the state at large may through the votes of its citizens choose the boards of regents who control the policy

of the state university; the educational system of the state may be represented by the state superintendent of the public instruction who may also be an *ex officio* member of a board of trustees; ecclesiastical bodies are as such sometimes represented on boards of trustees; the alumni now have representatives elected by and from their own number on many boards of trustees. But members of a college faculty have no voice whatever in the election of boards of trustees who control the policy of a college, nor have they any representation on the board of trustees. It is indeed sometimes said they are so represented by the president of the college, but since the president is elected by the trustees, not by the faculty, such a statement seems to be a mere juggling with words.

The question therefore of who is in actual control of our colleges and universities can be answered clearly, authoritatively and emphatically—it is the college president and the university president. The answer does not follow as a result of eliminating from the eight factors concerned in the problem all of the other seven whose authority has been shown to be either negligible or negative—it has been given in unmistakable terms on more than one occasion when a new college president has been elected or inaugurated, as also at other times and in other places.

The theory of the presidency is definitely stated in a series of statutes defining the powers and duties of the president that were drawn up a few years ago when a president was sought for an important university. They were formulated by the trustees after consultation with the leading candidate for the position, and they are given in full as being probably the most explicit statement as yet made concerning the office.

First. The president shall be ex-officio a member of each faculty, and it shall be his right and duty to preside at every meeting thereof.

Second. The president shall have the power of nominating the dean of each faculty, subject to the approval of the board of trustees.

Third. The president shall have the right to attend all meetings of the board and to address the board upon all subjects connected with the university. He shall be ex-officio a member of all standing committees of the board.

Fourth. The president shall have the exclusive right to transmit all communications from each faculty and from each member thereof, to the board.

Fifth. The president shall have the right to recommend to the board the vacation of professorships and other positions in all departments.

Sixth. The president shall have the exclusive right to nominate professors in all departments except in so far as this may be inconsistent with the contracts under which certain of the departments are now conducted.

Seventh. The president shall have ultimate authority in all matters of discipline.

Eighth. The president shall have the right to advise the board in all matters of expenditure.

Ninth. The president shall have control of all employees engaged in the preservation and maintenance of the buildings of all departments of the university, and he shall be the chief custodian of such buildings.

At another great university a popular professor of another institution was offered the presidency, but he

delayed his acceptance until he had come to a clear understanding with the regents as to their future relations. He said with much frankness that one great disadvantage of the University of ———— had always been the disposition of the regents to meddle in the internal management, especially in personal matters, such as appointments, promotions and salaries; and he received assurance that the initiative in these matters should rest with himself.

At a third great institution where the power of control came to be vested in a single person, it was announced that the trustee had paid "a high compliment to President ———— by giving him absolute power over the management of the educational affairs of the University."

At a fourth institution the candidate selected by the board of trustees dictated his own terms in accepting the office of president of a college and it was announced that "the board of trustees has accepted the principles proposed by ———— and all direction of the faculty will proceed from him."

At another time a university president took summary action in regard to several members of the faculty, and when "the persons concerned" asked the reason for the action they received the reply from the president, "I have no reasons to give. It is my pleasure." It is possible that the distinguished president was only unconsciously reflecting his morning lesson from Kipling,

> Now these are the laws of the Jungle,
> And many and mighty are they;
> But the head and the hoof of the Law
> And the haunch and the hump is—Obey.

The privilege of overriding legislation of the faculty is claimed by the president of at least one great university. Somewhat recently when the name of a student who was a candidate for a degree in arts was presented to the faculty, the head of one department reported that the candidate had not completed all the work prescribed by the faculty as necessary before obtaining the degree. The president refused to allow the faculty to vote on the case and later stated in the press, over his own signature, "that the president of the university has the authority and privilege of submitting to the trustees a recommendation for any degree without consulting any faculty or any member of a faculty."

These illustrations could be multiplied almost indefinitely. They seem to furnish some ground for the observation of a college professor that "the college presidency is a despotism untempered by assassination."

That the college president "is bearing up well" under these manifold duties and responsibilities and that unlike his brother politician in the state he does not "view the present situation with alarm" there is abundant evidence on every side to prove. He has in the first place written two or three books on the subject—that the number is so limited is in itself perhaps indicative of the insignificant part the whole subject takes in his mind. A more extended source of information is found in the memoirs of college presidents who have taken the public into their confidence. Occasionally the college president has written an anonymous magazine article; in one of these he has enlarged on the perplexities of his position, which he likens to those of a stage-coach driver compelled to prod one lazy horse into doing his share of the work while at the same time trying to prevent another spirited one from kicking over the traces. The near-professor was a near-instructor at the time he read this particular article, but he still vividly recalls the strong desire he felt to urge the college president to give up stage-coach driving for a living and get another job.

But the college president, unlike the college professor, seldom finds it necessary or wishes to conceal his identity. Educational reviews, educational associations, the inaugurations of brother presidents, and public educational functions of every description give him abundant opportunity to express his opinions in regard to the present distribution of powers between president and faculty and to give his general approval of the principle "it's heads I win and tails you lose."

At a somewhat recent inauguration of a university president, the previous incumbent of the position gave an address on "The University Presidency." In this he states that "the president must mark out his official course for himself and bear the responsibility of it without cavil. He can not expect that the work he has to do will make everybody happy. It will discomfit many. In one way or another they will give him all the trouble they can." This statement seems so absolutely final as to make it unnecessary to add further illustrations, many though there be at command.

But extreme as this statement of a former university president must seem to all who take an active interest in the organization of our educational system, much as these extreme statements are in themselves to be deprecated, irritating and exasperating as must seem the official relationships between college president and college faculty in view of this apparently prevailing conception of the college presidency as held by the college president, it must, after all, never be forgotten, even by those who suffer from the system, that the college president of to-day is the victim of the very virtues of his official predecessors. An overconscientious desire to do all that he should has often led him to undertake more than he can accomplish; a real desire to save his colleagues

from undue burdens has led him to assume tasks that his colleagues needed to perform for the sake of their own educational growth; a belief in his own divine right to rule—a belief born of his ecclesiastical ancestry—has carried with it the corresponding belief in the right of others to be ruled; a conviction that if it is his duty "to break in" an unruly team, it is the duty of the team to be broken in; all of these and still other inherited and accumulated beliefs explain the origin of conditions that in the great majority of colleges to-day result in probably more or less friction between the president of the college and the faculty. If there is little friction evident, it is because of strong personal attachment between the president and the members of the faculty individually —there is occasional lack of friction in spite of the system, not because of it.

But explanations, however reasonable and satisfactory they may be, do not alter the fact that the college president has not only freely expressed his opinion in regard to his own place in the educational system, but he has also on occasions shown why the present arrangement has been foreordained to perpetuity.

The first reason alleged for the continuance of the present system of external legislation and autocratic administration is that college faculties are unable to do business. "It goes without saying, and properly and without adverse criticism, that the temper of mind which turns a man to the higher forms of scholarship and to investigation and research is not the temper which fits him for executive work," is the statement of a former university president, but it was made before the election of President Wilson. Another president finds that "a faculty is made up chiefly of specialists, for the most part untrained in the business of administration and without special responsibility for the college and the larger relationships." Still a third finds "that a faculty that governs itself in an extreme degree is likely to be extremely conservative; it is likely to perpetuate traditions; it is likely not to be in touch with progressive thought," though the danger to be anticipated from faculty government is, in the opinion of a fourth, "its radical tendencies." This difference in point of view may, however, be explained by the geographical location of the two institutions whose presidents have given these judgments—one is east and one is west. And yet another emphatic, unqualified statement is made that "the very worst form of government for college or university is that of a faculty."

This very insistence on the inability of the corporate faculty thereby tends to make a faculty incompetent. That a man quickly becomes what he is thought to be has been learned in nearly every other field but that of normal education. Even those who deal with criminals are learning that the quickest way to make a man guilty of crime is to believe him capable of committing a crime, that trust and confidence

win a wavering man to the side of law and order while suspicion and distrust send him to the side of lawlessness and crime. But no hope seems to be held out for the college faculty—it ever hears from the platform and through the press that it is incapable of doing business and the discouraging feature of the situation is that the American college faculty is coming to believe it.

It is also asserted that the college professor does not wish to take a larger part than he now has in the direction of educational policy. "I have heard a good deal about the growing impatience at the amount of business detail forced on the faculty because of this faculty form of government" is the statement made by a university president. "By far the greatest number in every faculty neither desire to assume administrative burdens nor are extraordinarily competent for such tasks" is the opinion of another president. Even so eminent a man as ex-President Eliot has shown much solicitude on this point when he says:

> Most American professors of good quality would regard the imposition of duties concerning the selection of professors and other teachers, the election of the president and the annual arrangement of the budget of the institution as a serious reduction in the attractiveness of the scholar's life and the professional career.

The near-professor from the safe retreat of his desk in the middle west ventures to ask by what authority ex-President Eliot presumes to speak for the American college professor, why he assumes that the election of a college president, once in say forty years, should be a more serious reduction in the attractiveness of the scholar's life than is a vote every four years for the electors of the federal president, why the cooperative annual arrangement of the budget of an institution should be a greater infringement on the professional career than is the unaided preparation of the domestic budget with a limited salary and a growing family, why the implication is made that it is only professors of bad quality who grasp at things so far beyond their reach as the selection of professors and other teachers, and why indeed a representative of Puritan New England could imagine that even a college professor would falter in his duty if that duty led him for a brief period from the attractiveness of the scholar's life into the more arduous paths heretofore trodden alone by the college president.

Another reason assigned is the infirmities of temper charged up to the college professor. One president complains:

> Truly the academic animal is a strange beast. If he can not have something at which he can growl and snarl, he will growl and snarl at nothing at all.

Another reports that he has to deal with men "not altogether ripe for translation." It is a member of a board of trustees who arraigns the entire faculty over which he and his fellow trustees exercise jurisdiction with the seven deadly sins of "jealousy," "bickerings," "professional

incompetency," "demoralization," "discourtesy," "lack of discipline," and "laziness"—if this term properly translates the statements that "no original work worthy of note has been done by the members of the faculty," and that "the professors are practically unknown to the literature of their respective subjects, even after long years of identification with their respective departments of instruction." Truly the members of university faculties may set forth not only the private tables of university presidents, but also the extension dining tables of boards of trustees.

The near-professor recalled that he had once read the story of a conversation between Browning and a Jewish friend in which the latter had sought an explanation for the repugnance often inspired by some of his race and found it, he thought, in the difference in appearance and manner between the Jews and the Christians of a certain class. Browning replied:

> Naturally their characteristics would become more intensified through long exclusion from other groups of men; their manners would be unlike those of others with whom they were not allowed to mix. No wonder if, hedged in as they were, those peculiarities took offensive shapes. Does not every development, to become normal, require space? Why, our very foot, if you restrict it and hedge it in, throws out a corn in self-defense!

Still another reason assigned is that it is not the business of the faculty. "The business of university faculties is teaching. It is not legislation and it is not administration," is the emphatic statement of one president. "The special office of the faculty is to teach," states a second president. "The duties of a professor are investigation and instruction," adds a third. No statement seems to be so generally endorsed by college presidents as that "it is the business of teachers to teach."

It is altogether probable that college professors would agree that their chief, if not their only, *raison dêtre* is teaching, if the term teaching is made elastic enough to cover the time and opportunity needed to pursue knowledge. For how can the blind lead the blind, how can we make bricks without straw, are the ever iterated and re-iterated cries of those weighed down with the burdens of daily teaching, of those who have no opportunity themselves of drinking at the Pierian spring, yet must hold the cup to the lips of others. "Our function in the educational system is indeed teaching," they may well say, "but we must ourselves seek and find knowledge if we are to pass it on to others."

But who shall define the limits of teaching, or prescribe the boundaries of the educational field, or determine the nature of those questions that are "purely professional," or set now on this side and then on that the subjects that concern special departments and those that concern education in general? Teaching and new buildings, teaching and improved equipment, teaching and additional instructors, teaching and

academic freedom, teaching and pensions, are all questions of Siamese twinship. Who shall separate teaching from any other part of the educational body without thereby taking from it the breath of life?

It must be evident that the present method of collegiate organization has not only produced friction, for among all the colleges and universities located between Maine and California and between Florida and Washington the number can be counted on the fingers of one hand where there is no friction of an aggravated character either between the board of trustees and the president, or between the president and the faculty, but that it has also resulted in serious incongruities of conditions and of relationships.

Some of these incongruities are connected with the office of the president. They result from attempting to fit the round peg into the square hole and they would be amusing did they not so vitally concern our entire educational system. If a successful business man is elected the president of a college, he may inaugurate a campaign of efficiency in order to determine "just how much work each member of the educational staff is doing in the matter of instruction, what he is producing in connection with his chosen line of specialization and—in short—to determine his value to the institution as compared with that of his colleagues." If a person without even the first college degree is called to a college presidency, he may be solemnly asked in the first interview granted the representatives of the press to enunciate his views in regard to the graduate school. If a clergyman is transplanted from a city or a country parish to the presidency of a great university, he may at once begin planning for new schools of civil and mining engineering. If an eminent physician is invited to become a college president he may immediately promulgate fantastic schemes for strengthening the college by the introduction of a plan to promote friendly rivalry among the professors.

It is safe to say that if positions were reversed the incongruities would be apparent to all. No professor of mathematics would be called to the pastorate of a city church, no head of a department of modern languages would *ipso facto* be deemed qualified for the headship of a theological seminary, no professor of English could without special medical training receive a license to practise medicine, no professor of chemistry would be considered a qualified lawyer.

One of the most unfortunate features of the official relationship between president and faculty is that if a member of the faculty raises a question in regard to a matter of college policy it is regarded as an unjustifiable interference on his part. His question may seem to him altogether devoid of harm—he may ask in regard to the probable site of a new building, the nature of the campus hedge that is to be set out, or whether the city fathers have ordered the campus drinking water

boiled, but in any case he is probably warned that the shoemaker should stick to his last.

It is also unfortunately true that any criticism of the policy of the administration is often resented as "a personal attack on the president." A member of the faculty may question the wisdom of admitting students poorly prepared, or of retaining students whose ill health makes it difficult for them to do their college work, or of dismissing students who have presented a petition stating what they believe to be grievances, but all such questions are too often interpreted as "attacks on the president."

In one institution where autocratic rule has been carried to an intolerable degree, one of the professors at one time suggested some improvements that might be made in the institution. He was quickly removed and no protest was made by his colleagues either collectively or individually because they were too timid to do so or because they were too much hampered by the meager salaries paid to feel justified in running the risk of removal. But in spite of apparent acquiescence in the action of the president, one by one the members of a small group were dropped on the suspicion of being sympathizers with the erring professor because known to be his personal friends. They were afterwards pursued by a relentless persecution that for years prevented any of the number from securing positions in the educational field for which their ability and professional qualifications fitted them.

At the time of friction between a president and members of the faculty due to the unexplained demand made for the resignation of several of its members, the professors involved sent to the board of trustees a respectful petition asking for a full and open investigation of their work. This petition was characterized by the board as "rank insubordination," since a by-law of the university provided that all communications from the faculty should come to the board through the hands of the president. "The communication should be treated with just the respect it deserves," said a member of the board of trustees in a public meeting. "It is an insult to the board and to the President; it is rank discourtesy, and for one, I do not propose to stand it. I move the letter be sent to the writer." "And the board concurred," is the comment of the press, "smashing the right of petition at one very large and full swoop."

The policy of concealment that prevails makes it difficult for the public to know what the situation really is. The public knows that more than one university professor has been dismissed, or his resignation has been demanded "for the good of the institution," and it draws the conclusion that these are examples of martyrdom in the cause of academic freedom of speech. In a few instances such has been the case, but in other instances, men have been relieved of their positions because they have been incompetent to fill them. Such men have sometimes

chosen to assume that they were dismissed for holding opinions at variance with those of the administration, but those who have been familiar with the situation have wondered less that these professors were dismissed from their positions than that were ever appointed to them. To president and faculty alike lack of frankness and freedom of expression brings needlessly harsh and often unmerited criticism.

What wonder if members of college faculties, on their part, sometimes feel that they are employees, hired by the year, with a time-card, and with a "boss" to enforce discipline; that they are clerks in a department store with the floorwalker ever present to keep them at their tasks; that they are horses in stalls conveyed by railway train to some distant point unknown to them; that they are tagged and pigeonholed in the desk of the president; that they are parts of a machine, irresponsible for the results of its work. Yet they never forget that it is also true that at rare intervals great educational leaders have arisen who by natural ability and educational training have seemed ideally qualified for the headship of great educational institutions. And it has been unfortunately true that these leaders have led where there have been few to follow. Trustees, faculty, alumni and undergraduates accustomed to the old order have feared to break with the past and have turned back again when the path has narrowed and clouds have obscured the heights.

The inorganic nature of the college and the lack of relationship among its different parts is well illustrated in the typical college campus. This is crowded with buildings representing every period of architecture known and not infrequently having buildings that utterly refuse to be classified; every variety of building material has been used in their construction; when several buildings have been erected of the same material, as of brick, the incongruities are needlessly multiplied by the use of pressed brick, tapestry brick, cream brick, and every other variety and color known to the builder; when one form of brick has been somewhat consistently used, the trimmings of granite, of white marble, or of red sandstone, or of brown sandstone, add the seemingly inevitable note of discord. Even single buildings illustrate the same spirit. One college received the gift of a physics laboratory and the building was planned by the president and a local mechanic without any consultation with the professor of physics. In another university the president secured the funds for a new library building and this he felt gave him the right to decide on the plans for it and also to select its location on the campus; incidentally, the site selected was next to the athletic field. In another college, the planning of a large lecture hall to be occupied jointly by several departments was turned over to a young architect who had never planned an educational building of any sort. Without consultation with any of the departments concerned, the plans were drawn up, the building was erected, and the

members of the faculty moved in. That some rooms were to be used for classes in mathematics and others for work in modern languages and still others for English had apparently in no way affected the plans.

Nor are these conditions necessarily due to differences in the periods at which college buildings have been erected—they prevail on more than one campus where the greater number of buildings have been erected in a single generation during the incumbency of a single president. Nor are they always due to the selection of different architects—in more than one instance a single architect has planned the greater number of the buildings of a college campus, yet he has been the chief of sinners in including among the buildings he has planned those that range in style from the classical period through the gothic, romanesque and renaissance to a Queen Anne house, a French château, or a feudal castle for the president.

The Architectural Record has recently published a series of articles by Montgomery Schuyler on the architecture of American colleges and more than one of the articles has emphasized the lack of harmony and the absence of a consistent plan in the buildings of a college campus. The author writes of one college:

> Seemingly, there has been enough money spent on buildings to execute such a scheme (of unity and variety) handsomely and impressively. The actual result is simply deplorable in the crudity of the parts and the absence of anything that can be decently called a whole. . . . There is not a trace of a general plan. The disposition of the buildings in relation to one another is as higgledy-piggledy as the design of each considered by itself.

The architecture of college buildings and the planning of a college campus may not seem to come within the range of a discussion of the next college president, but in fact nothing else in the domain of education seems to illustrate so well and so vividly the incongruities of the educational system itself. What the college is in brick and mortar, that the college is in its organization and in its educational plan. He who runs may read the incongruities of the college campus, but he who loiters has perceived but dimly, if at all, the intellectual incongruities reflected through it.

In view of these conditions who shall be the next college president? A former university president at the recent inauguration of one of his successors enumerates some twenty qualifications that should be found in the man who fills the office, although he states that "the qualities which enter into the making of an ideal college president are very widely distributed and never can be found represented in a great many men."

The members of a college faculty are ready to accept this statement of the difficulty of finding the ideal college president. But unlike members of boards of trustees they are concerning themselves not with candidates for the position of president, but with the organization of

the presidency. And first of all it seems clear to one who "can easier teach twenty what were good to be done than be one of twenty to follow his own teaching" that the first plain duty is to recognize the existence of the situation and then frankly meet it.

A recent inquiry instituted among three hundred professors of science in this country seems to indicate that in the opinion of eighty-five per cent. of these the present conditions are intolerable. This opinion may be entirely wrong, but it behooves even the college president either to disprove it or to accept it. Since he is to-day, by the very nature of his position, an administrative officer and business manager, rather than an investigator, it seems improbable that he will be inclined to undertake such investigation as would give a larger basis for generalization than that already carried on by a college professor. Until such time, therefore, as the college president can broaden the basis of generalization already provided for him by a college professor he should accept the conclusions drawn and adapt his course to them.

This investigation seems to show that what many college professors to-day desire is not more administrative work, but greater legislative power. Time is now frittered away by college faculties in administration that ought to be done by the administrative officer; college faculties wish less rather than more of these responsibilities. But many college professors do believe that every question of legislation that concerns the educational work of the college no matter how remotely or how indirectly should be acted upon by themselves, that they should have representation on the boards of control, and most of all that they should be educationally enfranchised to the extent of choosing their own president. They would probably at the outset agree with Dr. Patton that "the qualities which enter into the making of an ideal college president are very widely distributed," and that "it is their assemblage and their blending in the charm of an engaging personality that creats difficulties and also makes the selection of a college president a weary search." Recognizing the weariness of the search, they would abandon it at the outset and concentrate their efforts on the consideration of what should be the organization, powers and duties of the presidency.

What many college professors also desire is greater community of interest and of action with each other and with their official head. College presidents are wont to boast of the infrequency of the faculty meetings in their own institutions and they seem to believe that one measure of their official success is their ability to dispense wholly or in part with such meetings. Yet what is needed for the good of the cause is not fewer but many more faculty meetings. College professors are tempted, under present conditions, to confine themselves exclusively to their own line of work; they do not make connections with the work of other departments, or seek out relationships between different branches of knowledge, or see things as a whole. The college professor has in large

measure been made what he is by the conditions in which he has been placed and he has lacked the courage to insist on having these conditions changed. But many men are conscious of the present, though not inevitable, limitations of vision, and they would most gladly welcome an opportunity to exchange opinions and experiences with others of the guild. Faculty meetings that should be genuine discussions of the large educational questions of the day would lengthen the range of vision of the college professor, perhaps even that of the college president; they would deepen and broaden his educational foundations; they would make him more sympathetic with the difficulties of his colleagues and more tolerant of opinions that differ from his own. "How can I hate a man I know?" asked the gentle Elia, and his own implied answer would be that given by the vast majority of college professors could friendly relationships be established among them. The great national learned societies whose annual meetings are a source of profit and inspiration to all who attend them show that college professors, given freedom of action, can conduct large meetings with decorum, and without bickerings and petty jealousies. Can it not be assumed that these same men in their own college faculties, were the opportunity offered them, could and would discuss large educational questions in the same tolerant, inquiring spirit? Is not the spirit of the seeker after truth the same both at home and abroad, and should not his own college receive the benefit of this spirit? Many men are heard year after year at the sessions of these learned societies whose voices have never been heard in their own colleges outside of their own class-rooms. Is not the college the loser, whether the college be interpreted as meaning board of trustees, president, faculty, students or alumni?

Members of college faculties want at least the opportunity of taking a more active part in the smaller as well as in the larger affairs of the college. Probably nearly every member of a college faculty belongs to a club that has rooms or a building of its own, and he finds there, hung in a conspicuous place, a "book of suggestions" wherein he is not only invited but even urged to enter any ideas he may have for the improvement of the club. He goes to the public library and he finds a box of slips whereon he may record the title and author of any book he thinks it advisable to add to the library. He works for a summer in the British Museum and one of the first books he sees is a portly volume in which he may register inquiries or make reports of conditions to be changed, and to all inquiries he speedily finds an answer recorded in the same volume, together with the thanks of the administration for calling attention to matters to be remedied. He dines on a railway train, and at the bottom of the menu card he finds an invitation to report to the officer named any lack of attention on the part of the waiters. He goes to a great railway restaurant and he finds there a request to report at the desk any complaint in regard to food or service.

In more than one line of public business he sees evidences of a friendly desire for cooperation between business managements and the general public.

It is probable that few persons, even few college professors, avail themselves of these privileges or heed these invitations and even urgent entreaties. Yet the very fact that such opportunities are given the public is at once a safeguard to the organization making them in that it forestalls carping criticism, and at the same time it affords an outlet to the ill humors that would otherwise poison the minds of even reasonable men. The situation is precisely the same as that involved in the resumption of specie payments, as long as men can not get a dollar in gold for every dollar of paper money they hold, they will continue to demand gold; when every paper dollar can be redeemed in gold at its face value, men prefer the more convenient paper bills to the gold coin.

But no "book of suggestions" now hangs in the office of a college president, no slips calling for ideas are circulated by boards of trustees among college faculties, no invitations to report leaks, screws loose, or balky window shades are sent out by managers of college buildings, no notice is posted in any college building asking college professors to register complaints of the failure of other college employees to have the lantern ready at the hour appointed for the lecture or to set up on time a piece of apparatus necessary for an important experiment.

Then, too, the college professor would like to have the next college president not only listen to his suggestions, but even go so far as to occasionally ask him for opinions! As it is, the college president when he first meets his faculty and in his public inaugural address states his own conception of the function of a college and outlines what his policy is to be in connection with the particular institution over which he has been called on to preside. It is not on record that he has ever asked the members of the faculty what their opinions are on these questions. He may not be an alumnus of the college or have ever served on its faculty, yet election to the presidency of an institution with which he has no personal connection and with whose history he can have been but imperfectly acquainted is assumed to endow him with omniscience and his utterances are received as those of a prophet. The college professor would sometimes like to play the rôle of prophet!

The near-professor passed a pleasant hour as he reorganized the office of the college presidency, and then he turned to his Quentin Durward and to the conversation between the Scot and the Bohemian who boasted of his liberty.

"But you are subject to instant execution, at the pleasure of the Judge."

"Be it so," returned the Bohemian; "I can but die so much the sooner."

"And to imprisonment also," said the Scot; "and where, then, is your boasted freedom?"

"In my thoughts," said the Bohemian, "which no chains can bind."

THE MATTER OF COLLEGE ENTRANCE REQUIREMENTS

By President FRANK L. McVEY
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IN the past several years a marked change has taken place in the attitude of colleges and universities toward the matter of entrance requirements. An examination of catalogues, articles and discussions, shows clearly the swinging of opinion from the former college view to the high school way of regarding the question. It is, moreover, now generally conceded that the relationship existing between the college and the secondary school is a part of the whole system of education and not a specific relation between two of the factors of that system. The growth in the high-school attendance and the emphasis upon the importance of it as a factor have been brought about by a clearer recognition of the high school in its relation to public education.

Perhaps the most fundamental point in all of this discussion is the fact that the secondary period in the school-boy's life is far more favorable than his college years to the free exploration of the boy.[1] Self-realization has come to be a motive that has reached down into the high-school period, and it has been found, in the opinion of able directors of secondary education, that restricted preparatory courses prescribed by colleges do not afford the experience needed in the high school. It is further stated that individual pupils can not know at the beginning of the high-school course that they can go to college four years later on. Moreover, it has been shown that the specification of subject matter for the four years of the high school tends to materially hamper rather than help in the direction of secondary education. The confusion in the requirements of different colleges east and west makes it impossible for the ordinary high school to meet the demands of all of them. The result is that those who have observed the boys and girls working in the high schools of the country have come to the conclusion that there is a wide discrepancy between preparation for life and preparation for college as defined in the ordinary entrance requirements. For these reasons and many others it has come to be felt that the high school should serve as an open door through which may pass the boys and girls looking for a larger education.

The placing of the emphasis upon citizenship and the efficiency of the individual seems to point conclusively to a larger freedom on the part of the high schools and their management to meet the specific needs

[1] Abraham Flexner, "The American College," p. 223.

of the group of young people who come to their doors. The recognition of the mechanic arts, household science and agriculture, together with the attempt to reflect the major industries of the community, have brought the vocational idea in conflict with the traditional one of culture. A middle ground seems to be the saner position to take, since it is possible, and ought to be possible, for young people to secure a blending of liberal and vocational training at the same time, and through this combination education can receive the proper emphasis upon its social significance. The combination of the two makes possible a closer relationship of the work which the boy is doing to the welfare of society. Consequently, it appears to many educators that the requirement of four years of work in any particular subject as a condition of admission to the college or university is illogical and unhappy as a part of the educational machinery. Yet, on the other hand, it is distinctly understood that the attempt on the part of the high school to reach out and enrich its curriculum does not, and must not, mean the teaching of too many subjects to the same students at the same time.

The report of the Committee on the Articulation of High Schools and Colleges to the Secondary Department of the National Education Association in 1911 presented not only the various considerations that may be advanced regarding the function and field of education in the high school, but endeavored to define the meaning of a well-planned high-school course, and why it should be adopted as the basis of college admission. It is accepted without argument that fifteen units should be required for admission to the college or university, and that the specific subjects that should be offered may be summarized as three units of English, two units of one foreign language, two units of mathematics, one unit of social science (including history), and one unit of natural science. This makes nine units, and to these should be added two more units, so as to enlarge the requirements to at least two majors of three units each, leaving four units to be used as best meets the needs of the individual.

The suggestions of the committee have been more than accepted by the action of the University of Chicago in the new entrance requirements adopted by the faculties of that institution.[2] Accepting as fundamental the requirement of fifteen units, the University of Chicago requirements place the first emphasis upon English and the demand for three units of that subject. The departure from the idea of the committee, and for that matter from the general plan adopted by most universities of the country, is in the option granted to the student in the choice of subjects for the remaining units. Seven units must be selected from five groups in the proportion of three in one and two in

[2] "Changes in Entrance Requirements at the University of Chicago," by C. R. Mann, *Educational Review*, September, 1911.

another. These groups are ancient language, modern foreign language, history or social science and science. The remaining five units may be selected from any subjects offered by the high school for graduation, but no student is to be admitted to the university on less than the fifteen units required for entrance.

Under the plan that has been outlined by the University of Chicago, it is possible for the student to enter the university without mathematics, or, if he takes another combination under the second provision of the plan, to present his credits without languages, either ancient or modern; or, he may enter with modern languages, mathematics or history, and without ancient languages or science. This statement of the plan, however, does not complete it by any means, since the university adds two additional features, one relating to the observation and control of students, and the other to the continuance of certain lines of work. There has been established a grading system, which automatically eliminates the student who falls below grade, while the university maintains a statistical comparison of school and college records, so as to follow up the work of the high-school student, not only after he has entered college, but to bring the comparison with his record as a high-school student. To this a third feature is added, namely, a conference of high-school men. Having entered college, the student must pursue one of the subjects followed in the high school, and by the end of the second year must have completed two years in history and economics, two years of mathematics and science, and be able to read a foreign language; and if he comes up for a degree he must have spent three years of work in one department and two in another. You have under this plan a systematic attempt to coordinate the work of the high school and the college through the entire course of both.

An examination of the table of admission units required in the liberal arts colleges of state universities, shown below, indicates a stricter adherence to type and quite a marked tendency toward a hardening of lines in the establishment of certain prescribed studies for entrance to the colleges of state universities. Under ordinary circumstances one would expect a closer coordination between the state universities and the secondary schools than in the instance of the privately endowed schools and the high school. The explanation for the advanced stand of the University of Chicago is to be found partially in the fact that her officers have studied the school situation more carefully perhaps than have those of other institutions, and partially in the fact of her location in a city well endowed with high schools. In most of the states the universities are compelled to hold to the general conditions existing in those states, rather than follow the lines of development in the older and better established communities. Consequently, while the state universities attempt certain vocational subjects, the practise in this direc-

tion is by no means so extended as it is in the case of the University of Chicago.

The average entrance requirements of the state universities are three units of English, one of science, one of history, and two and a half of mathematics. These correspond rather closely to the provisions set forth by the committee of the National Education Association, but that committee adds additional academic units in order to make a second major of three units. The vocational subjects permitted by the state universities amount on the average to two units, leaving the remaining units to be selected from foreign languages, mathematics, civics and history. The University of Minnesota has gone farther than any other state university in the larger freedom of election given in the prescribed English requirements. Two units of mathematics are demanded, and four units of English, while vocational subjects may make up the remaining number of units, if desired. Universities like Arizona, Kansas, California, Cornell, Georgia, Iowa and others do not accept vocational subjects for entrance requirements.

Most of the state universities have a system of courses based upon prescribed and free electives, prescribed limited electives and free electives, or upon the group system. The question of majors is left to take care of itself in most instances, the idea being that if the student is forced to take certain prescribed subjects, he will follow them up in his choice of electives. A study of the situation, however, shows that in the majority of instances where no majors are required the student scatters his free electives over a large number of subjects. Entrance to state universities is based upon the idea of the need of general knowledge and certain requirements for specific courses. That is, for the purpose of pursuing the social sciences, the student in the high school should have had elementary mathematics, foreign language and the beginnings of civics. This is merely an example of the point of view, and in support of this position it may be said that the student's preparation is materially limited from the college side if he enters upon his freshman year without some elementary training in science or mathematics. The movement to carry down into the high school the elementary work in these subjects is materially retarded, and the colleges are forced to establish courses of study in beginning languages and mathematics. Whether this is a calamity or not remains to be seen. The old Scotch university way of looking at it permitted any boy who thought he had in him the ability to carry on higher studies to go up to the university. No restriction was placed upon his entrance. The searching power of examinations was relied upon to determine his ability to maintain a standard sufficient for the granting of a degree. If, however, there can be aroused in the secondary period of the student's education a larger appreciation of his relation to society, some understanding of the forces

of nature, and some fundamental principles instilled relative to citizenship, with at least some glimmer of what it means to study, the colleges and universities have all that can be expected or hoped for.

TABLE SHOWING ADMISSION UNITS REQUIRED IN LIBERAL ARTS COLLEGES OF STATE UNIVERSITIES

Note.—Compiled from Catalogues, 1911, in the President's Office, University of North Dakota. Any table of this kind can not be complete and fully accurate. Its purpose is served if it shows the situation.

Names of Universites	Admission Units Total	Prescribed Units							Optional Elective Groups									
		For. Lang.	Eng.	Science	Hist.	Algeb.	Geom.	Total	Eng.	Math.	For. Lang.	Anc. Lang.	Science	Civics	History	Voc. Subj.	Elec. Units Available	Units to Gr.
Alabama...	14	3	3	1	1	1½	1	10½	3½	3½	3	5	2	1	3	2	3½	3½
Arizona....	15½	4	4	1	2	1½	1	13½	*	*	*	*	*	*	*		2	2
†Arkansas...	15½		4		3	2½	2	11½			8	8					4	4
†California..	15	4	2	1	1	1	1	10	*	*	*	*	*	*	*	3	5	3
Colorado...	15	4	3	2	2	1	1	13	1	2	2	2	2	2	2	2	2	2
Cornell.....	15	5	3		1	1	1	11	*	*	*	*	*	*	*		4	
‡Florida.....	12	3	3		2	1½	1½	11			1		1		1	1	1	1
Georgia....	14	2	3		2	1½	1	9½			*	*	*		*		4½	2
Illinois.....	15	3	3		1	1½	1	9½			4	4	6	1	3	2	5½	
Indiana....	16	3	3	1	1	1½	1½	11	*	*	*	*	*	*	*	*	5	5
Iowa.....	15	2	3	1		1½	1	8½	*	*	*	*	*	*	*		6½	
Idaho.....	16	6	3		1	1½	1	12½	1	1	2	4	2	½	2	2	3½	2
Kansas.....	15	3	3	2	1	1½	1	11½	1	1½		1	4	1½	3	1	3½	3
Kentucky..		Catalogue not available																
Louisiana...	12	1	3		1	1½	1	7½	*	*	*	*	*	*	*	*	4½	3
†Maine.....	14	4	3		1	1½	1	10½		½	2	2	3		2		3½	2
Michigan...	15	2	3		1	2	1	9	1	½	4	4	1½		2		6	4
Minnesota..	15		4			1	1	6		1	8	6	7	2	3	9	9	9
Mississippi.	14	1½	3	2	1	1½	1	10	*	*	*	*	*	*	*		4	4
Missouri....	15	2	3			1	1	7	4	4	6	7	7	1	4	3	8	4
Montana...	15	2	4	1	1	1	1	10		2	4	4	3	1½	1½	6	5	5
Nebraska...	15	3	2		1	1½	1	8½		*	*	*	*	*	*	*	6½	3
Nevada....	17	6	3	1	2	1	1	14	*	*	*	*	*	*	*	1½	3	3
New Mexico	16	3	4	2	2	1½	1½	14		1	1		1				3	1
‡N. Carolina.	14	5.7	3		2	1½	1½	13.7	Vary with course followed								3	
N. Dakota..	15	2	3	1	1	1	1	9	*	*	4	3	6	*	2	9	6	5
Ohio.....	15	4	3	1	1	1	1	11		2	4	4	4			2	4	4
Oklahoma..	15	2	3	1	1	1½	1	9½	1	1½	4	4	1	1	3	2	5½	4
Oregon.....	15	2	3	1	1	1½	1	9½	1	2	2	2	5	½	3	2	5½	3
Penn. St. College...	14	7	3		1	1½	1½	14	Election in required groups									
§S. Carolina.	14	2½	3	1	2	1½	1½	10½	1	1	2	2	1	1	1		3½	2
S. Dakota..	15		3			1	1	5	1	2	6	7	6	1	4	1	10	4
Tennessee..	14	4	3			1½	1½	10		4	3	4	4	1	4	4	4	4
Texas.....	14	3	3		2	1½	1	10	1	1	2	2	2	2	2	2	3½	2
Utah.....	15		3		1	1	1	6	*	*	2	*	*	*	*	6	9	
Virginia....	14	4	3		1	1½	1	10½	*	*	*	*	*	*	*	2	3	3
W. Virginia.	15	2	3	1	1	1	1	9	*	*	*	*	*	*	*		6	3
Vermont...	14½	7	3		1	1½	1	13½	*	*	*	*	*	*	*	*	1	1
Washington.	15	2	4	1	1	1½	1	10½	*	*	*	*	*	*	*	*	4½	4
Wisconsin..	14	2	2			1	1	6	*	*	*	*	*	*	*	*	8	4
Wyoming...	15	2	3		2	1	1	10	1	½	4	4		1	2		5	4
Av. Entrance Requirement	15	3	3	1	1	1½	1	10½	1	1	2	2	3	½	2	2	4½	2

Summary

Number of universities requiring 15 units for admission 25
Number of universities requiring less than 15 units 13
Number of universities requiring more than 15 units 5
Number of universities requiring less than 14 units 2

* Stars mean options, amount of credit offered not shown.
† Reduced to definition of unit.
‡ Deficiency of 2 units allowed.
§ Deficiency of 4 units allowed.
‖ Can postpone foreign language.
The figures refer to number of units that are offered for entrance.

This means that the movement of a few years ago to force down into the high school many of the subjects taught in the college must necessarily stop; that while the high school in the larger places may reach up to the fifth or sixth year, yet the college will still be called upon to give instruction in the beginnings of languages and of the sciences to even a greater degree than has been true in the past. If this will change the idea that so many points are required for graduation and that certain credits must be received, for one which will emphasize the thoroughness of preparation and ability to think, the whole educational scheme now existing in America will be materially improved.

In many of the states there are systems of organization that adapt themselves especially to the maintenance of fixed types of high-school courses, though this is not necessarily true of an administration of the system from a liberal point of view. The more important of the endowed colleges have established an examination board, which provides for the presentation of examinations in entrance subjects under uniform conditions. Such a plan has much to commend it, since the questions set are likely to be worked out carefully and the marking of papers carried on thoroughly and well. Yet it has a tendency to maintain certain lines of examinations and tends to place emphasis upon the topics specifically called for in examinations. There is, moreover, no public force behind it other than the desire on the part of small groups of students to avail themselves of its facilities to pass entrance requirements to the schools represented on the examination board.

The diploma plan of admission, sometimes called the "Michigan system," rests upon the supposition that high schools of certain types are likely to give instruction of uniform value. It has not, however, been accepted by many of the states, since the tendency is to establish, even in those states where the diploma method exists, inspection by persons designated by the state universities. This plan has much to commend it, and where the inspection is made by some one especially skilled in secondary work, rather than by a group of men from the faculties of the university, it produces good results.

In other states a high-school board has been established, with the

power of classifying high schools and of requiring certain courses of study from them and the fulfilment of certain conditions relative to equipment, selection of teachers and the form and character of buildings. In some instances, specifically in the cases of Minnesota and North Dakota, examinations are presented by the board, and in the last named state the high schools are required to accept them as the basis of promotion. This, however, is not rigorously adhered to and usually applies to schools of the second and third class that have hopes of becoming first-class high schools. In other instances, even where the high school board plan of examinations exists, principals' certificates are accepted in subjects for entrance to college, where the high schools have passed the inspection of the high-school board.

Too strict emphasis upon and adherence to specific courses of study result in lack of adaptation, regarding which much criticism has arisen. Just what credit shall be given for specific courses where the whole purpose of the high school is not taken into consideration is a question which arises again and again. This objection is fully met in the Chicago plan and partly in the average entrance requirements of state universities. The tendency in the latter instance, however, is to multiply the subjects in which credit can be given, in the hope of covering, as it were, the miscellaneous features of the high-school course.

So much emphasis has been put upon the "fitting for life" side of high-school work, that the ability of the ordinary high-school subjects to do this, even where they are called vocational, has not been brought into question. The president of a vocational college in his annual report for 1911 says:

> A more difficult aspect of the problem (referring to the question of entrance requirements) is the amount of credit that may be given to the study of vocational subjects in the high school. While the pursuit of vocational subjects in the high school would seem to be a natural preparation for the vocational college, and while some of the technical arts are better acquired in the earlier years, yet because the high-school course is designed to be a finishing course and covers the whole of the subject matter in an elementary and superficial manner, it does not give a preparation upon which the more intensive and mature college course may be built. The ground must be covered again by a more thorough method and the time that has been spent on the subject in the high school is largely wasted, while the general subjects that have been replaced are permanently lost. If the schools would separate the technical arts from the elementary consideration of principles, the former might be accepted by the colleges and the later course built upon them without loss of time and with real advantage.[1]

In the statement which has been quoted above, the president of Simmons College has pointed out one of the difficulties in the teaching of vocational subjects so-called, and in a measure justifies the attitude

[1] From the annual report of the president of Simmons College, December, 1911.

which the state university has taken in the matter of their acceptance. The high school is not a trade school and ought not to be considered one. But the problem, which has been looked upon as one largely interfered with by the admission requirements of colleges, is after all a problem associated with primary, secondary and higher instruction rather than any one of its parts. The secondary school, therefore, should be given a large opportunity to work out its place in the scheme of education and to determine for itself, more than it has been able to do thus far, just what scope and methods of vocational training should be introduced in its course. The attitude of the state university in accepting numerous small credits in miscellaneous subjects of a scattered nature tends to retard rather than to hasten a closer investigation of the situation, while the granting of a certain amount of option and liberty to the high schools in the determination of the subjects to be offered in their courses will undoubtedly tend to reduce the number and to hold them in lines that will be more adapted to the needs of the community. Unquestionably, uniformity in the schools is desirable so far as it means uniformity in subjects, time, amount and speed of instruction, but if it means uniformity of instruction by the requiring of individuals the same subjects without regard to their actual needs, it is under all circumstances to be avoided. Looked at broadly, the state universities occupy a vantage ground, in the first instance, in that they have not moved to radical attitudes which upon closer investigation of the problems involved can not be held, and in the second instance that they are not so conservative as to stand in their own light. They are really in the position of modifying somewhat the average requirements for admission to meet the needs of the high schools as they stand to-day and to give them larger local option in the settling of their problems, if they are willing to give over the choice of a certain amount of their credits to the high schools rather than continue the policy of accepting credits in many small subjects. These universities are a part of the school system, and the adjustment which takes place will be from the bottom upwards rather than from the top downwards, but in this adjustment there is need of all the wisdom which the universities may have, as well as the cooperation of all the factors involved.

THE LESSON OF CANAL ZONE SANITATION

By J. S. LANKFORD, M.D.

SAN ANTONIO, TEX.

WE have learned two great lessons in the construction of the Panama Canal. One is that with money, modern machinery and men who are healthy and happily situated there is hardly anything impossible in civil engineering and building. This matchless piece of work now nearing completion testifies to the constructive genius of man, and can not be studied at close range in all its colossal proportions without exciting wonder and admiration. It is impossible to get any adequate conception of its magnitude without personal investigation. The first impression is the unlimited audacity of man in ripping open the mountains, draining marshes and lakes, penetrating the jungles and impounding rushing rivers in an effort to throw two great oceans together. It is the greatest assault ever made upon nature; but the white man, brushing aside all obstacles and scorning danger, will soon have finished this greatest of all monuments of marching civilization. It is impossible to escape a deep interest in the employees and their environment; in the systematic and effectual supervision of the material, the supplies and the work, and in the general progress that has been made. The bigness of it all and its possibilities in changing the commerce of the seas, the destiny of nations and the history of peoples appeals to the imagination as well as to sober thought.

But these things are soon lost sight of temporarily in the contemplation of the greater lesson which is as broad as the human family of the present and of the future, for it touches human suffering and sorrow, and human happiness—the lesson of sanitation and health. The unhealthiest section of the globe, so acknowledged by all the world, has been converted into the healthiest. Accurate and unbiased records and reports have demonstrated this repeatedly and conclusively. The land of the jungle where the mosquito sang her weird song of death unmolested for four hundred years vying with the germs of dysentery, typhoid fever and pneumonia in the destruction of human life; the country where death with grim terror reigned as king, queen and prime minister has yielded to modern methods of sanitation and has become the home of health and happiness, a plain fact almost approaching the miraculous.

It is a mistake to think this has been done under military power. It has been accomplished by the forceful and efficient efforts of a corps

of intelligent sanitarians who have proven themselves master pioneers in the prevention of tropical diseases, and it stands out as a startling lesson that none should fail to learn. Nor has this great work been very expensive, as some newspaper writers assume without warrant. Taking the number of men employed and the amount spent for the prevention of disease it is found that about one cent per day per man has been expended. In comparison with similar expenditures in American cities it should not be forgotten that practically nine tenths of the cost of sanitation in the Zone is in mosquito fighting and quarantine. In order to appreciate what has been accomplished it is necessary to understand the condition of the country at the beginning of the occupancy.

The Canal Zone, ten miles wide and forty-five miles long, is composed of mountains of moderate height, marshy swamps, numerous small lakes, jungles, almost impenetrable in some places, and streams, the most important of the latter being the Chagres River, celebrated for malignant malarial disease. The temperature ranges from 65° to 100°, March being the hottest month. The average annual rainfall varies strangely in different localities from 75 to 125 inches. The fog, clouds and hot sun follow each other in quick succession. The heavy rainfall insures permanent stagnant water where the larvæ of the yellow fever and malarial mosquitos thrive in countless millions; the perpetual moisture, warmth and rich soil lead to extravagant growth of hundreds of varieties of tropical grasses, plants, flowers, vines and trees, furnishing favorable harbor for the insects; and there is an almost constant stream of decaying vegetable and animal matter pouring into lakes and marshes that are never drained. Decaying animal matter leads to the generation of innumerable flies, ever ready to convey disease, and the water supply is polluted, and pregnant with disease germs.

This is the condition of things now in the surrounding country, and was the condition of the Canal Zone when the United States took charge. It was bad enough in the wilds of nature, but worse in the habitation of man. Colon had no sewer system, and human excrement was disregarded; there was no proper water supply; the cisterns, puddles and lakes furnished convenient breeding places for mosquitos; the streets and sidewalks were in horrible condition, and sanitary ordinances were lamely drawn and poorly executed. There were no screens, and flies literally swarmed over the food.

The conditions were little better in Panama City and in the intermediate towns. Yellow fever had been endemic for hundreds of years, and epidemic when new material was available. Malaria was ever present, consuming the life blood and limiting the capacity of generation after generation of the native population, and attacking the unacclimated with vigor and fatality. Typhoid fever was very common, and the ravages of dysentery were sorely distressing. The history of

the Isthmus is inseparably linked with disease and death. For more than three hundred years it was the favorite highway from ocean to ocean and many thousands perished en route from tropical disease.

The Panama railroad is only forty-five miles long, but it took five years to build it, and the cost in human life has never been satisfactorily estimated. Two different times a thousand imported men all died within one year.

One of the most pathetic incidents in all the history of human effort was the failure of the French, and the awful toll of death the French people and the laborers paid for their ignorance of scientific sanitation, which came later and is now universally accepted. Gorgas himself says that the Americans could have done no better than the French without the knowledge of the mosquito as a disease carrier. De Lesseps stood at the very head of his class in his field, and he had the best engineers of his time, and the brainiest supervisors; he had ample money and the latest machinery; but death stood in the path of every effort, defying progress. His annual death rate for the eight years was about 240 per thousand, and, after spending over $260,000,000 he met with complete failure, a failure that glares like a death dragon from the old discarded machinery and seems to breathe forth from the very silence of many thousands of graves. Colon, with a population of ten thousand, has a cemetery with one hundred and sixty-seven thousand graves.

And this is the country from which yellow fever has been banished for more than six years; where the mortality from typhoid fever and dysentery has been reduced to the minimum; where malaria has become mild and controllable; the country where the deaths per thousand among canal employees, instead of De Lesseps's 240, is only seven and one half. It is almost unbelievable, but it is true. Among white American employees the death rate is less than three per thousand. The lowest death rate of any considerable number of people in the world is now found in the Canal Zone.

How this has been done is the interesting question and therein lies the great lesson. After a short-lived error which threatened a repetition of the French disaster the government wisely decided to improve the sanitary conditions first, and not send workmen to the slaughter. The unconquerable Gorgas with a good force of physicians, surgeons, nurses, expert sanitarians, skilled engineers and helpers, with ample supplies of disinfectants, were put in the lead. It was recognized that Colon and Panama City must be made habitable the first thing. The little city of Christobal was started by the side of Colon. Houses were built well off the ground, arranged for good ventilation, provided with scientific plumbing, and carefully screened so that the operatives might be protected from mosquitoes during sleeping hours. Colon and Panama City are in the Zone but do not belong to the United States govern-

ment. Sanitary and police authority over these places, however, had wisely been retained by treaty rights. The unsanitary condition of Colon was vigorously attacked. Lakes were drained and filled and oil was used freely where draining was impracticable; a good sewer system was installed and connection required; an adequate supply of pure water was brought from a distance and cisterns abolished; streets were graded and sidewalks built; wharves were constructed, and the tide water controlled; suitable ordinances were passed, order was established and sanitary regulations of every kind were rigidly enforced. A quarantine system was inaugurated that was unyielding and of great value. As soon as possible a modern hospital was built with up-to-date equipment and every possible facility for scientific investigation and the most skilled surgical and medical treatment. This hospital has grown to great dimensions and has few equals in results. The annual death rate of Colon under this method has been reduced from 50 to less than 20 per thousand.

Panama City, not quite so bad as Colon, was treated in a similar manner. Adjoining Panama City is Ancon, the attractive American suburb, where are established the administration buildings, and the great Ancon hospital, which has no superior anywhere, furnishing the employees every facility for recovery that money can buy.

The problems confronted in the intermediate country were somewhat different, but similar in principle. The trains were screened and regulations put in force for the protection of the public health. A number of living stations for employees were arranged along the railroad and every house was built well off the ground and screened. Now the real war against disease was begun, lakes and swamps that had never been drained since nature made them poured out their accumulated filth to the sea; those that could not be drained were oiled; ditches were dug only after the lines of skilled engineers so that drainage might be perfect; a large force of men were kept busy oiling three or four times a month all lakes, puddles, sluggish streams and marshes, so that mosquitoes could not breed. Each little station or town was furnished a pure water supply, brought down from the distant hills in some instances, and provided with an efficient system of sewers, or in some rare instances well arranged cesspools. The jungle was cut away some distance from all residences so that the mosquito could find no resting place. Plague-carrying rats and other vermin were destroyed. Disinfectants were freely used, and fumigation resorted to when necessary in handling contagious diseases. Rotting vegetable and animal matter, offal and garbage, were burned. The life and habits of the men were carefully regulated. Government dining halls furnished good meals, well cooked, and protected by screens; sleeping quarters were clean and neatly screened and comfortable; the hours of rest and labor

were well arranged; prohibition was strictly enforced; good dispensaries were established in convenient places; a hospital car was run with every train for the ill or the injured; medical and surgical service was skilled and prompt, and the hospital attention was second to none. But it was the *one cent per day per man* expended for the prevention of disease that worked the miracle.

It was a tremendous undertaking beset by human hardship and hazard and surrounded by difficulties apparently insurmountable. But the canal will soon be finished, and its construction has been made possible only by the intelligent application of our most recent knowledge of sanitation. It will mark a distinct era in human civilization, an era in which all else must and shall be subordinated to the prevention of disease. And this will not be altogether humanitarianism, for a human life has its commercial value, a definite value worthy of consideration.

One of the first results of this remarkable sanitary crusade will be noticed in Central and South America. Idle money of several nations is now restless and seeking investment; tropical peoples, depressed by climate, and enervated by centuries of disease, have not kept pace with the progress of the world, and opportunities for good dividends are easily found; and capital will throw every protection around employees for selfish reasons. Great commercial, agricultural and industrial development immediately follows new and important lines of transportation; and, in addition to the enormous investments of the United States government in the Zone, private capital will flow into the country in a steady stream. No individual, corporation or nation can afford to ignore this striking lesson in sanitation. The country will first be made fit for habitation and then development will follow. This movement will be far reaching, and will have its effect upon the history of Central and South American republics.

If this can be done in Panama, most unhealthy of all countries, what should we not accomplish in our own country, with so many superior advantages? Shall we go on permitting hundreds of thousands of people to die of preventable diseases like typhoid fever, malaria and tuberculosis? The heavy mortality from these and other diseases is highly discreditable to an enlightened people. It is a lamentable fact that while this marvelous transformation was taking place in the Canal Zone, poisoning patent-medicine makers and conscienceless food adulterators were spending money by the millions to defeat the purpose of the people to establish a health bureau in Washington to prevent disease and promote the public health. Our national, state and municipal health officers, and our citizens, should study this great lesson well and profit by it. Thorough instruction of our twenty millions of school children on practical sanitation would result in re-

ducing the mortality from preventable diseases by half in one generation. This proposition was demonstrated beyond all question in a great educational campaign on the mosquito in the San Antonio public schools several years ago in which the mosquito was completely exterminated.

It is an inspiring sight to witness this unseemly, death-ridden tropical country, changed into a place of beauty and a veritable health resort, right in the midst of disease and death. The Panama Canal is a wonderful feat of engineering, and we can easily imagine civil engineers attempting in the near future to conserve and utilize the motor power of the ocean waves and the trade winds. All due honor to the engineers.

But when the world's vessels sail through Lake Bohio, whose waters will be impregnated with millions of dollars worth of the rusting iron of the French failure, it will be a glorious triumph of scientific sanitation, and a great lesson to all nations and peoples down the centuries; an example that will be emulated and add much to human health, happiness and longevity.

A BIOLOGICAL FORECAST[1]

By Professor G. H. PARKER
HARVARD UNIVERSITY

THE biologist, like other organisms, has been evolved. The mutations of the Greek and Roman period never established themselves as permanent stocks. They were crushed out by that rank growth of political and theological weeds that finally destroyed itself by its own vegetative excesses. The prototype of the biologist of to-day is essentially a modern product and came into existence with the Renaissance. He is the man who lighted our torch of learning and handed it on to us. But this naturalist of the early days bears almost no resemblance to his modern descendant. Like all reformers, he was an eccentric oblivious alike to popular praise and ridicule. I picture him now with his collecting net under his arm, his hat bristling with the pinned trophies of the hunt, and the pockets of his great coat distended with bottles and phials, which, be it said to his honor, came home fuller in contents than they went out. He widened our horizon by discovering a charm in the reptile and the worm and, with his hand-lens as an instrument of war, he conquered the unknown inhabitants of slimy pools and green puddles. He was indeed in all respects the veritable "bug hunter." I might here quote with perfect appropriateness as descriptive of his sympathy with nature, a certain well-known passage about books in brooks and sermons in stones but I have been instructed to avoid anything that resembled a Phi Beta Kappa oration and so I desist.

Lest you think I have overdrawn my picture of our ancient progenitor, let me read to you a sentence or two from the pen of one who well represented his class and whose book, a "Synonymic Catalogue of the Macrolepidoptera of North America," was a delight to my boyish heart. I quote a few sentences of advice as to costume.

> I would further add that for these excursions a coat made of some light woolen material is preferable: linen coats are abominable, as the suspenders by the aid of perspiration, adorn the back of that garment with a St. Andrew's cross, which, though of no moment to our country cousins, is by no means desirable as we get within the city limits on our return homeward, if it be still daylight. This coat should be plentifully supplied with pockets, two inside breast pockets, one of great capacity to put the net rim and all in, if you don't want to carry it in your hand, the other for your handkerchief, segar-case, small glass jar, etc.; it should also have two outside pockets near bottom of coat, the one to put your collecting box in, and the other for lunch, which latter, although

[1] An address delivered at the annual banquet of the Brown University chapter of Sigma Xi, May 28, 1913.

when you start you think your breakfast will last all day, becomes of vital importance about the time the sun is directly over your head, when you will devour every crumb, and, like poor Oliver, cry for more. Carry a little india-rubber, leather or tin drinking-cup with you but don't put much water inside of you—it is deleterous during these tramps; once give way to the temptation of guzzling creek water and by the time you are ready to drag yourself home, you will be as near a gone case of foundering as any undertaker need delight to see. If you feel thirsty smoke segars, if you can't smoke moisten your lips with a little lemon-juice or whisky, but don't moisten with too much of the latter so that the last seen of you is adorning the corner of some fence, with the flies hovering around your mouth trying to ascertain whether it was "Mountain Dew" or "Lavan's Best Proof" that has put you in a position for your friends to be ashamed of you, sir.

How detailed and considerate the instructions are! That these old naturalists were proud of their outfits, we can judge from the fact that Linnæus, the passed master of them all, had his portrait painted in his Lapland collecting costume. There are many descendants of these worthies at this board to-night, but where among us is a single representative. As Joseph Jefferson once said in describing his own person, we find ourselves disguised in the clothes of gentlemen, and no one here this evening has moistened his lip with "Mountain Dew," not to mention lemon-juice.

But what did these old masters do for us? They undertook and partly performed the enormous task of delivering to us a descriptive catalogue of the animals and plants of the world. To be sure this seemed a simpler proposition in the old days when, as Linnæus declared, there were as many species as had been created in the beginning. But even then the number must have seemed considerable, for Linnæus himself gave us descriptions of over four thousand species of animals. Probably, however, he had no suspicion that the total of described animals alone was to rise in our day to half a million and even after this heavy draft, nature would still have the appearance of inexhaustibleness.

But nature is not only vastly richer in species than the older naturalists probably suspected; she is continually at work creating new forms. The simple faith of Linnæus in the special creation of animals and plants was forever overthrown by Darwin, whose "Origin of Species" established a new point of view for this whole question. And recent evolutionary work has shown that organic transformation is not only in progress to-day, as it has been in the past, but, in the hands of man, it is rapidly assuming the aspect of an important element in civilization. Within the last few years such mastery has been gained over the factors controlling the color of the hair of some of our smaller and more rapidly breeding mammals that, within reasonable limits, a pure breed of guinea pigs of a previously designated color, for instance, can be produced in an incredibly short time. And when it is kept in mind that some of the colors thus produced had long been sought in vain by the old-

fashioned animal breeders, the advantage of the new methods over the old must be apparent. Instances of this kind give us good reason for believing that before many years have passed useful forms of animals and plants will be produced on demand, not in the somewhat haphazard way of the present practise of breeders, but with the certainty and precision with which a modern inventor constructs a new piece of machinery.

This change in the aspect of evolutionary matters can not be better illustrated than by three quotations that preface one of the most important publications on evolution in the last decade, "Species and Varieties, their Origin by Mutations." The quotations, which are arranged in historical sequence and come from the three great masters in this field, are as follows:

> The origin of species is a natural phenomenon.—Lamarck.
> The origin of species is an object of inquiry.—Darwin.
> The origin of species is an object of experimental investigation.—De Vries.

The last statement, that the origin of species is open to experimental study, is the keynote to modern evolutionary work. But it is not simply the keynote to this particular part of biology; it marks a change in front of the whole army of biological workers whereby the science of the organism is being transformed from one of observation pure and simple to one which includes experiment. We sometimes hear astronomy, chemistry, physics, etc., described as the exact sciences, and our friends in these domains of knowledge occasionally take a hidden pleasure, I suspect, in intimating that what lies outside their realm, including biology, must belong to the inexact category. That biology has not been exact in the sense that physics and chemistry have been, we freely admit, but physics was not always exact, and before the days of Lavoisier, chemistry had few quantitative results of which it could boast. Biology, from the nature of the materials it has had to master, has of necessity been slow in growing to that stage where it was imperative to use those refined methods that have long been employed by physics and chemistry. But these methods are rapidly being assimilated by the more progressive members of the biological fraternity, who are discovering that there is nothing inherently inexact about the subject-matter of biology or its treatment. This subject-matter is open to the same searching method as is that of the so-called exact sciences. But though we are not yet admitted to full fellowship with these sciences, we are at least the center of the observational group and, if we wished to retaliate on our good friends of the exact sciences, we might declare them non-observational with as much reason as they call us inexact. But you will accuse me of falling into a word controversy. And such it would be. The truth is that biology is rapidly becoming experimental, and in doing so it necessarily assumes all those methods and procedures that have long been

the special possessions of the exact sciences. As a result of these coming changes we expect to see biology established in a short time as an observational science of a highly exact order.

This general change, though characteristic of the last decade, may in reality be said to be no change at all, for the experimental attack on biological problems had its inception in the early days of the science. Its growth, however, has been limited almost entirely to the narrow field of human physiology, and the physiological laboratory is now proving to be a source of inspiration and help to the biologist as he faces the new set of problems put before him by the experimental method. It is customary to date the beginning of experimental physiology from Harvey's discovery of the circulation of the blood, not because this important discovery was a central biological fact, but rather for the reason that it was the first considerable discovery in physiology that was made by a rigid application of the experimental method, a method which has made possible almost all the subsequent progress in this field of research.

It is the acquisition of the experimental method that is converting the old biology into the new. Never before in the history of the science has there been such an expansion as the last decade has witnessed. Without diminishing activity in the fields that have long been under cultivation, this change has added enormously to the territory open to biological investigation. We still need revised and improved catalogues of the animals and plants about us, even though we now know that the unit of this kind of work, the species, is a highly artificial conception and that in nature all is in slow but continual flux. We need to know more about the distribution of animals and plants past and present, about their gross structural composition, their methods of development, their mutual interdependencies, their lines of descent, and the like. Biology is still a rich field for the purely observational worker, but the new territory laid open by the experimental method is, to my mind, the land of greatest promise. This method brings us face to face with some of the most fundamental problems of the organism, the solution of which, in my opinion, will yield results of the utmost importance to mankind. At this stage it would be presumptuous to attempt to predict what these results may be. But I can not let the present moment pass without hazarding a guess at a few of them.

No organism can exist long without food. Every animal and plant is appropriating materials by the chemical readjustment of which it is gaining the energy necessary for its own activities. We, as organisms, form no exception to this general rule. Our food, like that of other omnivorous animals, comes from animal and plant sources, but ultimately all food is drawn from the green plant. Destroy completely all green plants and in a short time all other organisms on the earth would

die of starvation. The green plant is the one independent organism on the globe; all others are in a way parasitic. As you well know, the green plant in sunlight elaborates starch from water and carbon dioxide, and the primitive food thus synthesized becomes the basis for further changes whereby nitrogen and other materials are built into the body of the plant. Thus arise the starches, sugars, oils and proteid materials which constitute the substance of the plant body and which serve us as foods, absolutely essential to the continuance of our lives.

In my opinion the time is not far distant when we shall be emancipated from this slavery to the green plant. No seriously minded chemist of the present day believes that there is any inherent impossibility in the repetition of the chemical processes of the organism, in the laboratory. The days of this form of vitalism have long since passed away. The difficulty that confronts the biological chemist in attempting to repeat the chemical processes of the organism is the enormous complexity of even the simpler of these operations. Hence he has not yet achieved that kind of success that even the scientific public seems to expect of him. But is this expectation reasonable? Are we warranted in finding him wanting because he has not yet made an amœba? I think not. To ask him to make an amœba is like asking an engineer to duplicate New York City. With infinite toil and pains it could be done. But who or what would be the better? One New York is enough. Better study the processes of New York or the amœba than attempt to duplicate in totality either organism and, having learned what these processes are, apply them to human welfare. This is the attitude we must assume toward the green plant. We must learn its processes and, having learned them, we must apply them to our needs.

If the green plant in sunlight can elaborate from water and carbon dioxide one of our chief food substances, starch, there is no reason why the biological chemist should not discover the secret of this process and imitate it on a commercial scale. Starch, I believe, has never been synthesized, but some sugars have been so constructed. Two years ago Stoklasa and Sdobnicky made the remarkable discovery that by the action of ultraviolet light on nascent hydrogen and carbon dioxide sugar was formed. Such discoveries as this suggest the means by which we are to throw off our slavery to the green plant and I am convinced that in time this overthrow will become so complete that our staple foods will be the products of the biological chemist.

From this standpoint the attitude of many of our pure food enthusiasts seems to me entirely erroneous. Why object to the cheaper synthetic colors and flavors in prepared foods provided they are not poisonous in themselves and contain no injurious by-products? As a matter of fact these very colors and flavors are often purer than the natural materials. From the point of view of public morals, such mixtures

should be rightly labeled, but to stigmatize them as necessarily inferior to the natural products is, to say the least, unprogressive. We do not object to artificial indigo because the chemist has superseded the green plant in its manufacture. Why, then, should we object to a currant jelly composed of wholesome artificial products? It may not only be as good as the old-fashioned kind, but I can imagine that a connoisseur in this new venture might impart to it a flavor even more delicate than that from the kitchen. Our descendants, I am sure, will some day sit down to dinners of synthetic dishes, the products of clean laboratories, with as much appetite and pleasure as we now partake of a meal hewn from the animal and dug from the earth, and we must not object if they prefer, on esthetic grounds, the source of their food to that of ours.

But food is only one of the many things we need. We number ourselves among the very few organisms that use tools and we need energy to drive many of our tools. Historically we have abandoned in much of our work the muscle for the steam engine. Contrast the construction of a modern building by a handful of Italian workmen and a donkey engine with the wall pictures we have of the long lines of Egyptian slaves straining every muscle as they pull a heavy load at the end of a rope.

But have we done best to ignore the muscle? When this organ is functioning at its highest, it yields two kinds of energy, heat and power to do mechanical work about in the proportion of two thirds heat to one third work. From the energy that enters the ordinary steam engine about one tenth is given back in work and the other nine tenths are dissipated as heat. Even in the highest grade of turbine engines, this efficiency seldom reaches as much as a quarter of the available energy. Thus the muscle returns us over thirty per cent. of its energy in effective work, and the best steam engines only about twenty-five per cent. If we knew the secret of muscle action, I have no doubt that a mechanism could be constructed that would far outrun the steam engine as a means of doing work.

Another kind of energy that we seek is light. Primitive man was forced to content himself with the sun by day and the moon and stars by night. When he first struck fire, artificial light came as well as warmth, and from that day to this we have witnessed a long succession of improvements in the production of artificial light. But in none of these has man rid himself of the association of heat with light. Every device for illumination that has been put forward yields more heat than light. Our ordinary gas flame yields between one and two per cent. of light and the remaining ninety-eight or -nine per cent. is lost in heat. No wonder that the modern gas corporation is advertising itself as a convenient source of heat and power. Many of us who serve it as consumers have come to regard this by-product as the most impor-

tant part of its output. We can at least feel what we are paying for, if we can not see it. But the electric lights far outrun the gas lights in efficiency. An ordinary carbon incandescent lamp yields about six per cent. of light to ninety-four per cent. of heat, the arc lamp about ten per cent. of light, while the mercury arc has climbed to the enormous efficiency of almost half light to half heat. This indeed is prodigious compared with the means of illumination of a few years ago.

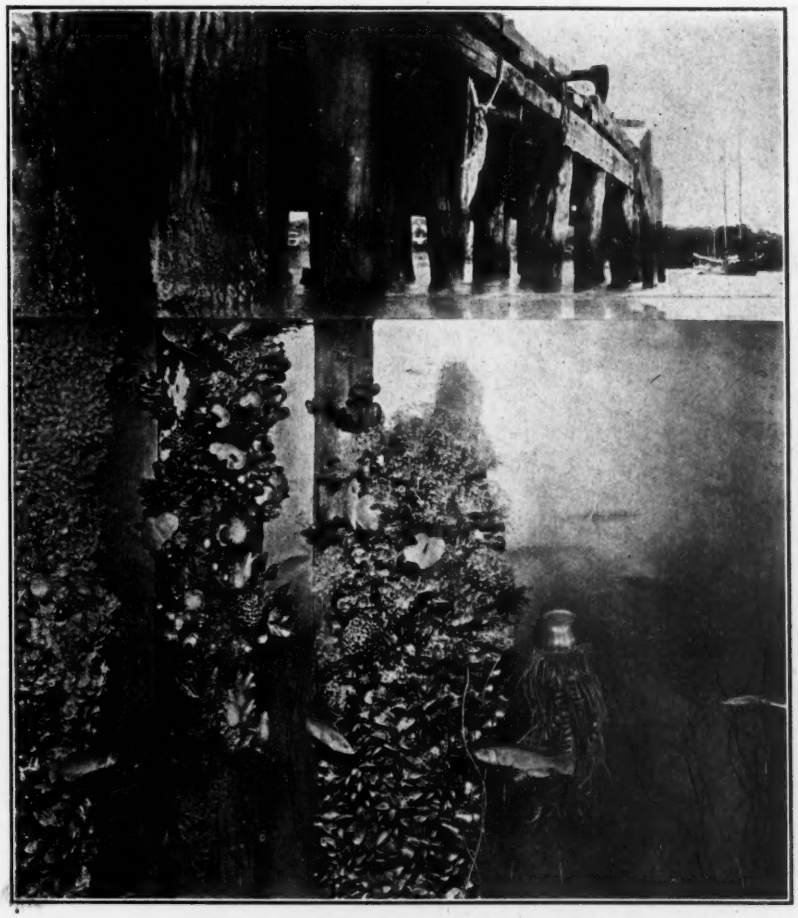
But what have the organisms to teach us in this respect? Many animals and plants are luminous. The simple one-celled animals, jelly fishes, worms, clams, insects and common fishes all have luminous representatives. But who ever heard of the sea being appreciably warmed by its phosphorescence or of a child who burned his finger with a firefly? Animal light is produced without heat, it is immensely the most economical form of light. Repeated and recent study of the firefly light has shown that all of its energy lies within the visible spectrum, that it contains not a measurable vestige of heat. Its efficiency is complete and could we discover, as we shall some day, the secret of the firefly light, the only occupation that would be left for our municipal illuminating plants would be that of heat generators.

By this time you must surely have caught the drift of my idea. For ages past animals and plants have been slowly evolving processes on some of which we have come to be absolutely dependent. Biology has now advanced to that stage where the study of these processes is beginning to be seriously undertaken. In my opinion the operations of plants and animals will serve as models on which to build up industry on a scale that human endeavor has never dreamed of before. Our modern industrial world supplies man's wants by means of what I may call inorganic devices. The future industrial world will draw more and more from organic models. In my opinion we are on the verge of an enormous expansion in applied biology. A century from to-day and our work will look as small and insignificant in comparison with the biology of that period as Franklin's electrical experiments do when brought face to face with the enormous electrical expansion of modern times. He saw in nature a few manifestations of a gigantic power which the modern man of science has brought under control. It is vouchsafed us in this early day to see dimly and indistinctly the powerful forces of organic nature and to receive the conviction that in the not distant future, these too are to be bridled and led by man. Such to my mind is the forecast of biology.

THE PROGRESS OF SCIENCE

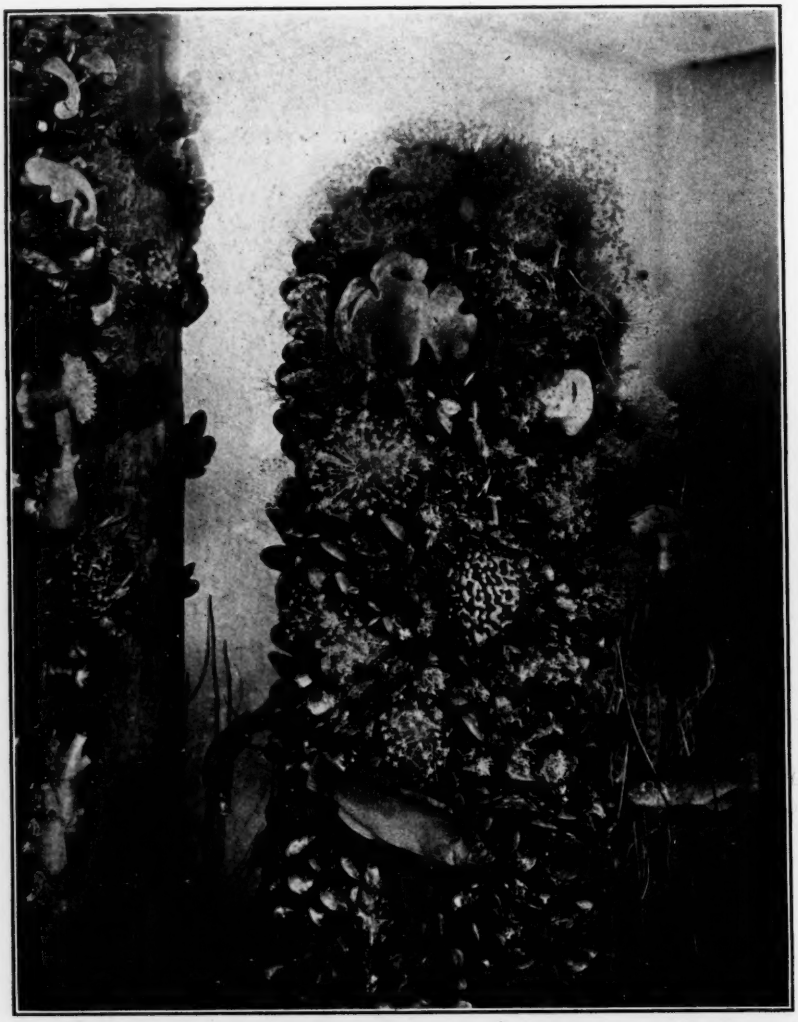
WHARF-PILE FAUNA IN A MUSEUM GROUP

THE oceanic waters that lap our shores conceal beneath their tidal margin a wealth of animal and plant life that is surprisingly unfamiliar to those who are not actually students of marine biology. As terrestrial animals ourselves we live and move in the midst of a world of air-breathing creatures with which most of us have become tolerably familiar. Beasts, birds, reptiles and insects have for us an economic or esthetic bearing that gives them a



THE VINEYARD HAVEN WHARF PILE GROUP.

The upper background is made up of enlarged photographic transparencies showing the actual locality. Below the water line, the animals and plants of the wharf piles are represented largely by models. The submarine background effect is produced by five successive sheets of plate-glass through which daylight filters from a window behind.

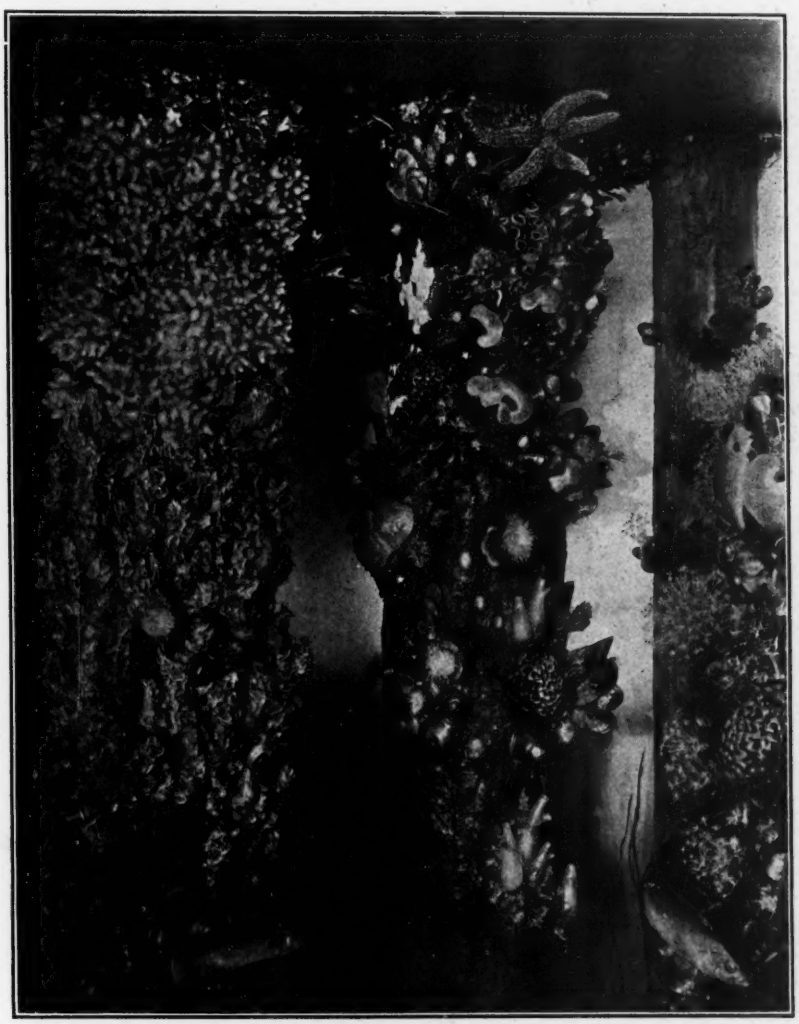


The broken pile in the foreground of the group with its colonies of mollusks, hydroids, sponges and ascidians.

place in the daily life of every one. The same is true of our terrestrial plants. But while the sea is familiar to us in its outward aspects, while certain of its creatures are well known to us because of their food value or for other reasons, yet the vast majority of the life that crowds that watery atmosphere has been effectually concealed from the generality of mankind by the density of the medium in which it lives. This is true not only of the animals of the deeper waters but of those that people the very margin of the sea as well. Here in the shallows life abounds. Here the struggle for existence is fiercest, and it is here that the closest adaptations to environment may be seen. These ocean margins were doubtless the theater of much of that tremendous evolutionary progress which in Archean times laid down the foundations of the great phyletic groups of the animal kingdom.

In order to give a picture not only of the abundance, variety and beauty

of the sea life of our littoral waters, but also of the delicately balanced and interlocking associations of the animals and plants composing it, the American Museum of Natural History in New York has been installing a series of groups representing the actual conditions under which this life occurs at certain definite localities on the Atlantic coast. Photographic and painted transparencies are arranged to show the surroundings at the locality in question while the animals and seaweeds are represented partly by actual specimens and partly by models colored from life. The latest of these groups, as shown in the accompanying photographs, reproduces the animal and plant colonies to be found living below the low-water mark on the wharf piles in the neighborhood of Vineyard Haven, Massachusetts. The upper part of the group represents an old abandoned wharf between the piles of which may be seen



The pile to the left is covered with the tubes of serpulid worms, overhung by the yellowish masses of the ascidian, *Molgula*. Starfishes, mollusks, barnacles, sponges, sea-anemones and six species of ascidians are seen on the central pile.

glimpses of the cottages on the further shore of the harbor. In the foreground the water is shown as though sectioned to disclose the submarine portions of the wharf piles with their bewildering display of living forms. In the center of the foreground a broken pile is completely covered by a colony of edible mussels (*Mytilus edulis*) over which has spread the pink and saffron clusters of a delicate hydroid (*Tubularia crocea*). Other species of hydroids are interspersed with fleshy masses of rosy-pink "sea-pork" (*Amaroucium pellucidum*), while glowing dully in the center is an orange-red colony of the beautiful red-beard sponge (*Microciona prolifera*). A graceful yellow and pink-tinted jellyfish (*Dactylometra quinquecirra*) with frilled mouth and fringed umbrella floats near the pile, and a school of squid (*Loligo pealii*) swims back and forth among the long thread-like filaments of the alga known as the "devil's shoe-string" (*Chorda filum*). The pile to the left is encrusted with the tubes of serpulid worms (*Hydroides dianthus*), whose many-colored gill circlets are protruded flower-like from all parts of the pile, and overhanging these are the yellow masses of the ascidian *Molgula manhattensis*. On this and the neighboring piles are also scattered in wild profusion sea-anemones, starfishes, moss-animals and several species of ascidians besides those already mentioned. Most of these are sessile animals and form an admirable illustration of adaptation to an inactive life and a diet of microorganisms, as contrasted with the swiftly moving and voracious fishes and squid shown elsewhere in the group.

Other groups which have been completed in this series are the "shore mollusk group," showing the animals of a sand-spit at Cold Spring Harbor, Long Island, and the "Woods Hole marine worm group." A group to illustrate the invertebrate animals of a Nahant rock tide-pool is under construction.

THE INTERNATIONAL MEDICAL CONGRESS

THREE important international congresses were arranged for the month of August, two of them on this continent. The Congress of School Hygiene meets at Buffalo just after the issue of the present number of the MONTHLY. The Geological Congress met at Toronto, and the International Medical Congress at London earlier in the month, but only the cabled accounts of the latter congress are at hand in daily papers. It is gratifying that these should be somewhat full, *The Boston Transcript*, for example, devoting as much space as two columns in a single issue to cabled despatches. The proceedings of a medical congress, more especially those parts relating to public hygiene, can with advantage be brought to the attention of the widest possible public.

International medical congresses were organized in Paris in 1867 and have since been held at four-year periods. The second congress was held in London thirty-two years ago under the presidency of Sir James Paget. Among those who took part in its proceedings were Pasteur, Virchow, Charcot, Koch, Huxley and Lister. Since that time vast progress has been made in the medical sciences and in their application, but it may be that a generation hence none of those taking part in the present congress will be so widely distinguished.

The general sessions of the congress were held in Albert Hall. The address in medicine was given by Professor Schauffard, the distinguished French physician; the address in surgery by Dr. Harvey Cushing, recently called from the Johns Hopkins University to Harvard University, and the address in pathology by Professor Ehrlich, of Frankfort. The general addresses were continued on the two following days, when Professor William Bateson spoke on heredity and Mr. John Burns, president of the British Local Government Board, gave an address on public

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PROFESSOR CHARLES F. MARVIN,

Professor of Meteorology in the U. S. Weather Bureau since 1891, Chief of the Instrument Division, appointed Chief of the Weather Bureau, to succeed Mr. Willis L. Moore. Mr. Marvin is here photographed with the barograph, which is among the important meteorological instruments which he has invented.

health. There were on the program the titles of some 600 papers and some hundred formal discussions distributed among 23 sections. Among the great number of subjects included in the program there may be mentioned almost at random a discussion on tropical sanitation by Sir Ronald Ross, who advocated a separate department of state to deal with the health of the community; an account by Surgeon General Sir David Bruce of his investigation of sleeping sickness in Nyassa Land, where he found half of the wild animals to be infected; Dr. Van Logham, of Amsterdam, foretold the spread of yellow fever to Asia and Australasia through the opening of the Panama Canal; Dr. Ehrlich explained the mechanics of his laboratory, through which he had obtained his 606 different combinations, of which the last had become so important; Dr. S. Kitasato, of Japan, presented a report on the plague, and Dr. Shirayama on the cause of beri beri; Dr. George W. Crile, of Cleveland, spoke on the surgical effects of shock; Dr. Clarence M. Blake, of Boston, on climatic and occupational influences in diseases of the ear; Dr. K. F. Wenkelbach, of Strassburg, on the pathology of heart failure. Sir Thomas Barlow, the president of the congress, made an address at the general session and other English representatives made addresses before the sections over which they presided. Sir E. A. Schafer made the address on physiology; Sir Anderson Crichett, on ophthalmology; Sir Malcolm Morris, on dermatology; Sir J. Mackenzie Davidson, on radiology; Sir Lauder Brunton, on therapeutics, and Sir David Ferrier, on neuropathology.

There were three prizes awarded by the congress, one established at Moscow was given to Professor Ch. Richet for his work on anaphylaxis; the prize established at the meeting in Hungary, to Professor Wright for his work in the same subject, and the Paris prize to Professor A. von Wassermann, the newly appointed head of the Kaiser Wilhelm Institute for Experimental Therapy, for his work on immunity.

The congress passed a resolution to the effect that "It is our conviction that experiments on living animals have proved of the utmost service to medicine in the past and are indispensable to its future progress." The seven thousand members were entertained at dinners, garden parties and other functions in the manner which is only possible in the well-organized system of English society. The meeting of 1917 will be in Munich. Four years later it might well be in the United States.

SCIENTIFIC ITEMS

WE record with regret the death of Professor John Milne, distinguished for his work in seismology, and Dr. Robert von Lenderfeld, professor of zoology in Prague.

M. PIERRE BOUTROUX has accepted a professorship of mathematics at Princeton University, and will assume his duties in the autumn. M. Boutroux is a son of the distinguished professor of philosophy, M. Emile Boutroux, and is closely related to the Poincaré family. —Dr. J. S. Kingsley, professor of zoology in Tufts College since 1892, has accepted a chair of zoology in the University of Illinois.

THE Kelvin memorial window in Westminster Abbey was dedicated on July 15. The dean of Westminster made the address and the ceremonies were attended by many distinguished scientific men. The window, which was designed by Mr. J. N. Comper, is in the east bay of the nave on the north side. The light from it falls upon the graves of Kelvin and Isaac Newton, and immediately beneath it are the graves of Darwin and Herschel.